(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 December 2000 (28.12.2000)

PCT

(10) International Publication Number
WO 00/79807 A1

(51) International Patent Classification[7]: **H04Q 3/00**, H04L 12/66

(21) International Application Number: PCT/IB00/01236

(22) International Filing Date: 16 June 2000 (16.06.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/334,961 17 June 1999 (17.06.1999) US

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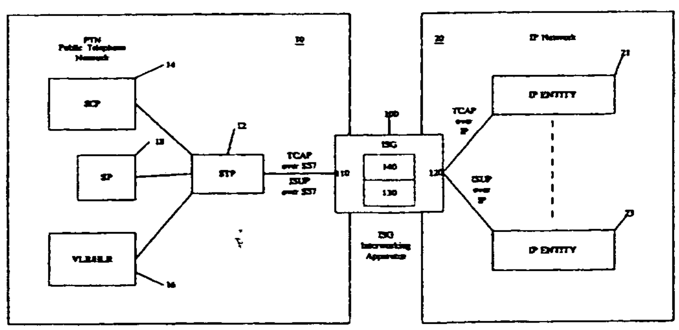
(81) Designated State *(national)*: CA.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SIGNALING GATEWAY



(57) Abstract: An apparatus, system, and method are provided for interworking reliable signaling and services between a public telephone (PTN) network and an internet protocol (IP) network. The public telephone network transports an ISUP and/or TCAP message in a first format, while the internet protocol network transports an encapsulated ISUP and/or TCAP message in a second format. A first interface exchanges messages in the first format with the public telephone network, and a second interface exchanges encapsulated ISUP and/or TCAP messages in the second format with the internet protocol network. A processor translates ISUP and/or TCAP messages in the first format to/from the encapsulated ISUP and/or TCAP messages in the second format. The processor forwards messages in either format to the respective network. The first format can be the SS7 protocol format used in a public telephone network, while the second format can be the IP protocol format used in an internet protocol network. Network interconnection addressing and routing remapping functions are included. Network load sharing and fail-over switching functions are provided. An apparatus for exchanging encapsulated ISUP and/or TCAP messages with the internet protocol network is included. A system for interworking a public telephone network and an internet protocol network is provided. The system comprises a first network node, a second network node, and at least one interworking apparatus having a processor adapted for exchanging ISUP and/or TCAP messages in either format with the respective networks, as described. Related methods for interworking and translating messages between networks are provided.

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SIGNALING GATEWAY

FIELD OF THE INVENTION

The present invention relates to telecommunications and networking, and more particularly to an apparatus, system, and related method for interworking services and reliable signaling between public telephone networks, Intelligent Networks, and Internet Protocol (IP) networks.

BACKGROUND OF THE INVENTION

Telecommunications originated over a century ago using traditional landline based telephony technology. Over time, standards, protocols, and topologies were developed and optimized to provide telephony services. More recently, wireless telephony was developed as an alternative means of telecommunications. Wireless telephony evolved with its own separate and distinct standards, protocols, and topologies optimized for the mobile telephony environment. The SS7 (Signaling System 7) network was developed to provide digital out-of-band signaling channels for both the landline and wireless telephone networks. The modern public telephone network (PTN) leverages SS7 capabilities to establish telephone call connections and provide advanced services, such as 800 or toll free, calling card, Intelligent Network services, Call Back, Calling Name Delivery, Local Number Portability and wireless roaming services. In addition,

new architectures and interfaces have been developed recently that permit further integration and cooperation between landline and wireless telephony networks. It has been proven advantageous to share resources and provide PTN services more generically, without being concerned whether the telephone terminals involved in the communication are landline or wireless.

Recently, IP (internet protocol) networks were developed in parallel with the converging landline and wireless telephony infrastructures. Many IP networks, such as the public Internet, have been created and effectively interconnected. While the PTN network was developed primarily to provide end to end connections between telephone service subscribers, IP networks were developed to interconnect and leverage the information and processing capabilities of millions of networked computers. Given the substantially more complex purpose of the IP network, it evolved as a separate network infrastructure with distinct protocols optimized for the functions to be provided.

Over time, the functions provided by the PTN network have become increasingly more sophisticated. Therefore, it is not surprising that cooperation between the IP network and PTN network is desired, and in some instances, required. Accordingly, it would be advantageous to provide services to the PTN network from the vast resources resident in IP networks. Public telephone networks and IP networks have been interconnected to some extent. In this regard, one early application used the IP network to setup a connection and establish a voice telephone call. The IP telephone call can be originated from any telephone terminal, such as a conventional telephone terminal or an appropriately equipped computer connected to the IP network, and placed to another telephone terminal, such as any other conventional telephone terminal or another appropriately equipped computer connected to the IP network. While this capability is useful, the IP telephone calls are only capable of establishing an end to end connection across the IP network. As such, telephony signaling and services cannot effectively cross the IP network and PTN network border, although the need for doing so persists. For instance, it would be advantageous to provide calling card billing verification from database servers operating in an internet protocol network. Further, it would be advantageous to provide signaling functions through IP network resources. For example,

it would be advantageous to extend telephony signaling to, and through, internet protocol networks to further leverage the vast resources of IP networks. Accordingly, it would be advantageous to provide SS7-like links in these internet protocol networks, such that the signaling and reliability advantages of SS7 signaling networks could be extended to internet protocol networks.

In order to effectively converge and leverage these distinct networks, true signaling and services interworking is required. Interworking is defined as transporting a message between a first network entity executing a software application program in a first network domain and a second network entity executing a software application program in a second network domain. In other words, interworking refers to exchanging messages between software application programs executing in different network domains. As such, interworking requires the exchanges of telecommunications messages, such as ISUP (ISDN User Part) messages and TCAP (Transaction Capabilities Application Part) messages, between entities in different networking domains, such as an internet protocol network and a public telephone network. Accordingly, a call processing application executing in an internet protocol network and a call processing application executing in a public telephone network need to exchange ISUP messages for establishing end to end telephony connections and providing full interworking. Further, a TCAP application executing in an internet protocol network and a TCAP application executing in a public telephone network need to exchange TCAP messages to provide services and full interworking.

In addition, once fully functional interworking is provided between a public telephone network and an internet protocol network, the challenge of providing highly reliable interworking must be addressed. Public telephone networks achieve very high levels of network availability by leveraging fault tolerant hardware and software, such as redundant telecommunications switches and redundant network paths established between network nodes in public telephone networks. The SS7 network supports redundant network path capability by providing diverse SS7 links and linksets, and by leveraging the load sharing and fault tolerant features inherent in the SS7 protocol. Consequently, a very high level of reliability is provided by, and expected from, any

resources used by the public telephone network. For example, some network components in the public telephone network can only be unavailable to the network for a maximum of two minutes per year. In order to maintain the very high availability level of a public telephone network, the components used therein, or connected thereto, must be extremely reliable in operation. In contrast, Internet protocol networks and the components typically used therein are very unreliable as compared with the highly reliable public telephone network. Accordingly, a need exists to provide high reliability levels when interworking an internet protocol network to a public telephone network, whether the interworking involves services, signaling, or both. It would be advantageous to provide an internet protocol network interworking solution that provides load sharing, hot or active standby, and high reliability as required in a public telephone network.

As such, a need exists for a fully functional and compatible interworking solution between the IP network and the PTN network. Were this solution achieved, telephony based services could be provided as necessary from a public telephone network, an internet protocol network, or both. The interworking solution must also provide the signaling, load sharing, and high reliability attributes necessary to compatibly interface with the SS7 protocol and the public telephone network. With a compatible solution, existing services and signaling could be provided more effectively from an internet protocol network. A number of other advantages would also likely emerge from full, compatible, and highly reliable interworking between an internet protocol network and a public telephone network, as was observed from the convergence of the landline and wireless network infrastructures.

SUMMARY OF THE INVENTION

The present invention provides an apparatus, system, and method for interworking services and reliable signaling between an IP network and a public telephone network, including the Intelligent Network and wireless networks. As such, the present invention addresses at least some of the above needs while providing some advantages. According to the present invention, conventional TCAP messages from the public telephone network can be exchanged with encapsulated TCAP messages in the IP network. Software

application programs executing in network nodes disposed in the IP network and in the public telephone network can thereby cooperatively process information and exchange services therebetween. Existing services can be provided to telephony services subscribers, while new services could be developed by leveraging the processing capability of network nodes in the IP network, according to the present invention. According to the present invention, conventional ISUP messages from the public telephone network can be exchanged with encapsulated ISUP messages in the IP network. Software application programs executing in network nodes disposed in the IP network and in the public telephone network can thereby cooperatively process information and provide signaling and related functions therebetween. As such, the present invention can provide services, signaling, or both between an IP network and a public telephone network.

In one embodiment, the present invention provides an apparatus for providing signaling and services interworking a public telephone network and an IP network comprising a first interface, a second interface, and a processor. Since the public telephone network transmits and receives a message in a first format of a first type and the IP network transmits and receives a message in a second format of a second type, interworking between network domains is required. The first interface is used for communicating with the public telephone network, and is adapted to exchange messages in the first format of the first type with the public telephone network. Analogously, the second interface is used for communicating with the IP network, and is adapted to exchange messages in the second format of the second type with the IP network. Further, the processor is operably connected to at least one interface and adapted for translating the message received in the first format from the public telephone network into the second format, such that public telephone network addressing and routing information in the message received is converted for the internet protocol network, and wherein the processor is adapted for forwarding the message encapsulated in the second format to the IP network. In another embodiment, the processor is further adapted for translating the message received from the internet protocol network in the second format, such that internet protocol network addressing and routing information in the message received is

converted for the public telephone network, and wherein said processor is adapted for forwarding the message in the first format to the public telephone network.

Other embodiments further define the formats and interfaces used in the interworking apparatus. The first format can be an SS7 protocol format, while the second format can be an IP protocol format. The first type of message may be an SS7 ISUP or TCAP message, while the second type of message may be an encapsulated ISUP or TCAP message. Further, the first interface may be adapted to exchange TCAP messages or ISUP messages with the public telephone network, while the second interface may be adapted to exchange encapsulated TCAP messages or ISUP messages with the internet protocol network.

An embodiment of the present invention further comprises a storage memory operably connected to the processor for maintaining addressing and routing information related to the public telephone network and the IP network. This storage memory may contain a table correlating a plurality of IP network node addresses and a plurality of public telephone network node addresses, such that the processor can remap the address of an incoming signaling message received from one network into a destination address in the other network. In one embodiment, each IP network node address may comprise an IP address and a port number, and each public telephone network node address may comprise a point code and a circuit identification code for converting ISUP signaling messages received from either network. Further, each public telephone network node address may comprise a destination point code and a global title or a subsystem number for converting TCAP messages received from either network.

A further embodiment adapts the processor to serve as a signaling end point for the public telephone network, while another embodiment adapts the processor to serve as a signaling transfer point to the public telephone network. Further, the processor and first interface can be adapted to operate as one or more SS7 signaling links, such as an A Link, B/D Link, E Link, or paired combinations thereof, for interfacing with the public telephone network. In addition, the processor and second interface can be adapted to operate as one or more pseudo SS7 signaling links, such as an A link, an E link, or both, for interfacing with the internet protocol network. The SS7 signaling links supported in

each network through the respective interfaces can operate in coordination. Accordingly, one embodiment adapts the processor to exchange signaling messages with the public telephone network and the internet protocol network, such that load sharing of signaling message traffic can be provided by the apparatus among network entities or nodes in at least one of the public telephone network and the internet protocol network. Further, one embodiment adapts the processor to exchange signaling messages with the public telephone network and the internet protocol network, such that hot standby processing of signaling message traffic can be provided by the apparatus among network entities or nodes in at least one of the public telephone network and the internet protocol network. In addition, the processor can be adapted to reroute a signaling message received from either network to a backup network destination entity in the other network when the signaling message cannot be delivered to a primary network destination entity or node.

In a further embodiment, the present invention provides an apparatus for selectively interworking the public telephone network and the IP network which comprises means for communicating with the public telephone network, means for communicating with the internet protocol network, and means for translating messages. The means for communicating are adapted to exchange ISUP messages and TCAP messages over the SS7 protocol format with the public telephone network, and adapted to exchange encapsulated ISUP messages and encapsulated TCAP messages over the IP protocol format with the internet protocol network. The means for translating is adapted for translating an ISUP message and/or a TCAP message in the SS7 protocol format in the public telephone network to/from an encapsulated ISUP message and/or an encapsulated TCAP message in the IP protocol format in the internet protocol network. The apparatus can translate ISUP and TCAP messages received from one network into the proper format for transmission to the other network.

One embodiment of the present invention further provides an apparatus for exchanging signaling messages with an internet protocol network comprising a first interface and a processor. The IP network is adapted to transmit and receive a second type of message in a second format. The first interface is used for communicating with the IP network, and is adapted to exchange messages in the second format of the second

type with the IP network. The processor is operably connected to the first interface, and is adapted to process a message of the second type encapsulated in the second format received from the IP network through the first interface. Further, the processor is adapted to forward a message of the second type in the second format to the IP network through the first interface. Accordingly, messages of the second type encapsulated in the IP protocol format can be exchanged with the IP network. In one embodiment, the processor and first interface are adapted to operate as one or more pseudo SS7 signaling links as described with the internet protocol network.

The present invention further provides another embodiment of an apparatus for exchanging signaling messages with an internet protocol network, comprising means for communicating with the internet protocol network, and means for translating. The means for communicating are adapted to exchange encapsulated ISUP and TCAP messages with the internet protocol network. In addition, the means for translating is adapted to extract an ISUP message and/or a TCAP message from an encapsulated ISUP message and/or an encapsulated TCAP message received from the IP network. The means for translating can encapsulate an ISUP message and/or a TCAP message and respectively forward an encapsulated ISUP message and/or TCAP message to the internet protocol network, such that the encapsulated ISUP and TCAP messages can be exchanged with the IP network.

One embodiment of the present invention provides a system for providing signaling and services interworking between a public telephone network and an internet protocol network, comprising a first network node, a second network node, and at least one interworking apparatus. The first network node is operably connected to the public telephone network, while the second network node is operably connected to the internet protocol network. The interworking apparatus is operably connected to at least one of the first network node and the second network node. Each interworking apparatus further comprises a first interface, a second interface, and a processor. The first interface is used for communicating with the public telephone network, and is adapted to exchange ISUP messages and TCAP messages in a first format with the public telephone network. The second interface is used for communicating with the IP network, and is adapted to exchange ISUP messages and TCAP messages in a second format with the IP network.

Further, the processor is adapted to extract an ISUP message and/or a TCAP message received in the first format from the public telephone network and forward an encapsulated message containing an ISUP message and/or a TCAP message in the second format to the IP network. In addition, the processor is adapted for translating an encapsulated message containing an ISUP message and/or a TCAP message in the second format received from the IP network and forwarding an ISUP message and/or a TCAP message in the first format to the public telephone network. The various aforementioned formats and message types are supported by the system. In addition, the first and second nodes can be connected to either interface, can reside in either network, and can be operably connected to at least one interworking apparatus.

In one advantageous embodiment, the first network node and second network node each comprises a processor. The processor in the first network node is adapted to exchange ISUP messages and TCAP messages in the SS7 protocol with an interworking apparatus, while the processor in the second network node is adapted to exchange encapsulated ISUP and TCAP messages with an interworking apparatus. Accordingly, the first and second network nodes can exchange ISUP messages and/or TCAP messages and communicate through an interworking apparatus. In one embodiment, each processor is adapted to execute a TCAP application software program, such that the TCAP application software programs in the first and second network nodes can communicate through at least one interworking apparatus and thereby exchange telephony services. Further, each processor can be adapted to execute an ISUP application software program, such that the first network node and the second network node can exchange telephony signaling therebetween.

Another embodiment of the system comprises a first interworking apparatus and a second interworking apparatus, operably connected to each other such that messages can be exchanged therebetween. The first interworking apparatus and second interworking apparatus are connected to the first network node and second network node respectively, such that messages can be exchanged between the first and second network nodes through the operably connected interworking apparatuses. Further, the first and second interworking apparatuses can be adapted to emulate at least one pseudo SS7 signaling

link as described above, so as to emulate the respective SS7 signaling link for interfacing with the second network node through the internet protocol network. The first and second interworking apparatuses can emulate at least one SS7 network reliability function selected from the group consisting of load sharing, active standby operation, primary/backup operation, network node bypass, and failover operations, between the first network node and the first and second interworking apparatuses. Accordingly, the system can provide highly reliable signaling and services from IP network resources.

An embodiment of the present invention provides a system for providing signaling and service interworking between a public telephone network and an IP network, comprising a first network node, a second network node, and at least one interworking apparatus. The first network node is operably connected to the public telephone network, while the second network node is operably connected to the internet protocol network. The interworking apparatus is operably connected to at least one of the first and second network nodes. Each interworking apparatus further comprises means for communicating with the public telephone network, means for communicating with the IP network, and means for translating. The means for communicating with the public telephone network is adapted to exchange ISUP messages and TCAP messages over the SS7 protocol format with the public telephone network. The means for communicating with the internet protocol network is adapted to exchange encapsulated ISUP messages and encapsulated TCAP messages over the IP protocol format with the internet protocol network. The means for translating can translate an ISUP message and/or a TCAP message received in the SS7 protocol format from the public telephone network, and can respectively forward an encapsulated ISUP or TCAP message in the IP protocol format to the internet protocol network. The means for translating can also translate an encapsulated ISUP and/or TCAP message received in the IP protocol format from the internet protocol network, and respectively forward an ISUP and/or TCAP message in the SS7 protocol format to the public telephone network.

A further embodiment of the present invention provides a method for providing signaling interworking between a public telephone network and an IP network, comprising the steps of receiving at least one of an ISUP message and a TCAP message,

extracting at least one of the ISUP message and the TCAP message, and encapsulating at least one of the ISUP message and the TCAP message. The step of receiving at least one of an ISUP message and a TCAP message comprises receiving at least one of an ISUP message and a TCAP message from the public telephone network in an SS7 protocol format. Next, the method comprises a step of extracting at least one of the ISUP message and the TCAP message from the SS7 protocol, and thereafter encapsulating at least one of the ISUP message and the TCAP message in a second format, such that at least one of the ISUP message and the TCAP message can be forwarded to the IP network to permit signaling interworking therethrough. The method may further include the step of transmitting at least one of the encapsulated ISUP message and the encapsulated TCAP message in the IP protocol format to a network node in the internet protocol network, after the encapsulating step. In addition, the method may further comprise the step of decapsulating at least one of the encapsulated ISUP message and the encapsulated TCAP message in the IP protocol format received by the network node in the internet protocol network, to permit recovery of at least one of the original ISUP message and the original TCAP message. The method may further comprise the step of forwarding at least one of the received ISUP message and the received TCAP message in the SS7 protocol format to the public telephone network, after the decapsulating step. As such, the aforementioned apparatuses, systems, and methods provide fully functional services and reliable signaling interworking between an IP network and a public telephone network by leveraging ISUP and TCAP messages in various compatible formats across network domains.

BRIEF DESCRIPTION OF THE FIGURES

Figures 1(a) and **1(b)** are block diagrams comparing the interface between a public telephone network and an IP network, prior to the present invention and according to one embodiment of the present invention, respectively.

Figure 1(c) is a block diagram showing one configuration of the apparatus for interworking an IP network and a public telephone network, according to one embodiment of the present invention.

Figure 2(a) shows a block diagram illustrating an apparatus for interworking network entities in the IP network and the public telephone network, according to one embodiment of the present invention.

Figure 2(b) is a block diagram illustrating SS7 and pseudo SS7 links and linksets supported in the IP network and the public telephone network by the apparatus for interworking, according to one embodiment of the present invention.

Figure 2(c) is a block diagram of the ISUP and TCAP message processing capabilities of the apparatus for interworking network entities in the IP network and the public telephone network, according to one embodiment of the present invention.

Figures 3(a) and **3(b)** show respectively the TCAP message exchanges and the ISUP message exchanges supported by the apparatus for interworking network entities in the IP network and the public telephone network, according to one embodiment of the present invention.

Figures 4(a) and **4(b)** respectively show an SS7 A link and an SS7 E link between two or more public telephone network entities.

Figures 5(a) and **(b)** show respectively two systems according to the present invention including SS7 links and pseudo SS7 links supported by the apparatus for interworking, according to one embodiment of the present invention.

Figure 6 is a diagram illustrating an IP entity apparatus for exchanging TCAP and ISUP messages through the IP network, according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these

embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limiting the scope of the present invention in any way.

As described above, the public telephone network developed significantly earlier than the Internet Protocol (IP) network. Two separate and distinct network domains and infrastructures evolved independently, as shown in **Figure 1(a)**. For some time, there was no gateway operating between an IP network **20** and a public telephone network **10**. Eventually, the capability to establish a telephone call from an IP telephone terminal to a telephone terminal in the public telephone network was developed. This is shown by the dashed line between the public telephone network (PTN) and the IP network in the Figure. However, this capability only establishes an end to end connection between the respective networks, and as such, is of limited usefulness.

The present invention provides fully functional advanced services and reliable signaling interworking between a public telephone network and an IP network, as shown in **Figure 1(b)**. Different messaging formats, addressing, and routing found in the IP network and public telephone network are reconciled. Accordingly, TCAP messages are transported between network domains. TCAP software application programs operating in the public telephone network and IP network exchange and process TCAP messages. TCAP based services can therefore be exchanged between the IP network and public telephone network. Thus, advanced telephony services can be provided by the public telephone network, the IP network, or both.

In addition, public telephone network signaling and links/linksets are extended to the IP network by the present invention. Accordingly, through interworking functions provided by the present invention, both ISUP and TCAP messages are transported between network domains. ISUP software application programs operating in the public telephone network and IP network exchange and process ISUP messages to establish telephony connections. By utilizing the extended signaling and SS7 links/linksets configurations provided to the IP network from the public telephone network, highly

reliable signaling functions and related services can be provided by the public telephone network, the IP network, or both.

As shown in **Figure 1(c)**, an integrated signaling gateway (ISG) **100** is used to translate signaling messages between the SS7 protocol and the IP protocol. Through the signaling gateway, the signaling gateway functions shown in **Figure 1(b)**, including services and reliable signaling can be provided across network domains. The signaling gateway serves to translate and transport ISUP and TCAP messages between the IP network and the PTN or public telephone network. Interworking the divergent internet protocol and public telephone networks creates a cooperative processing environment for leveraging the respective capabilities of each network. For example, telephony services or reliable signaling could be provided from the PTN network, the IP network, or both. The present invention provides apparatuses, systems, and related methods for providing comprehensive and fully functional interworking between the PTN public telephone network and the IP network.

Terminology

Discussion regarding the present invention will be facilitated by establishing the meaning of terminology to be used herein. Other terminology not expressly defined herein should be interpreted as the term is normally used by those skilled in the art.

Call Server/Controller (CS)

The Call Server performs signaling and call control functions for IP (Internet Protocol) clients, ie. Voice over IP telephones and Media Gateways. The Call Server can handle the registration and management of resources at the Media Gateway. In addition, the Call Server may authorize resource usage based on local policy, for example, based on the attributes of both the end user and the ISP (Internet Service Provider).

Directory Number (DN)

Telephone number or subscriber number associated with a telephone terminal.

Global Title Translation (GTT)

An SS7 routing function that translates a logical address to a physical SS7 address and possibly, a subsystem number, which identifies the application that will process the message whose address is being translated.

Home Location Register (HLR)

A database containing permanent and/or temporary information regarding the telephony services subscribed by, and the location of, a wireless telephone terminal serviced by the public telephone network.

IP network

Any network operating with the IP protocol, such as corporate intranets, local area subnetworks, other IP networks, or the public Internet network.

Internet network

A worldwide network of backbone interconnected computer networks, each including uniquely addressable, interconnected computers. The computers are interconnected by a communications medium through identical or compatible messaging formats, such that the respective computers can interact effectively and share information.

Internet Protocol (IP)

A worldwide standard messaging format or protocol used in the public Internet network and any internet protocol (IP) network comprising network layer functions in the OSI model protocol stack.

Internet Service Provider (ISP)

Provider of access to the Internet and/or to services on the Internet Protocol networks.

Interworking Signaling Gateway (ISG)

A network entity that provides a fully functional interface for exchanging TCAP, ISUP, or both types of messages between the PTN/SS7 network and the IP network, in order to support fully functional services and reliable signaling interworking therebetween.

ISDN User Part (ISUP)

The call control portion of the SS7 protocol, which is used between PTN switches to control all telephone calls.

Links/Linksets

Communication links used for signaling between network nodes or entities in the SS7 signaling network, which provide out of band signaling for the public telephone network. Links can be paired or combined into linksets in order to provide redundant and highly available signaling connections between network nodes. According to the present invention, pseudo SS7-like links/linksets are provided in the IP network in order to extend reliable signaling to network nodes or entities in an IP (Internet protocol) network.

Media Gateway (MG)

A Media Gateway terminates PTN facilities, such as trunks or loops, packetizes the media stream for the IP protocol if not already packetized, and delivers packetized traffic to the Internet/IP network. Examples of Media Gateways are NAS (Network Access Servers) and VoIP (Voice over IP) gateways. The NAS and VoIP functions may or may not be combined within the same gateway.

Message Transfer Part (MTP)

The lower three layers in the SS7 protocol, which provide physical, data link, and network functions. The network layer functions provide message routing between signaling points in the SS7 network. MTP is analogous to the lower three layers in the OSI model protocol stack.

Mobile Identification Number (MIN)

Telephone number or subscriber number associated with a wireless telephone terminal.

PTN (Public Telephone Network)

A public circuit switched telephone network, including landline, wireless, or both types of telephone network infrastructures. The PTN may include local telephone network components, long distance telephone network components, or both owned by a PTN service provider or carrier.

Service Control Point (SCP)

A node or network entity in the SS7 network and Intelligent Network that provides centralized service logic, serves as database, and provides call routing information.

Service Switching Point (SSP)

A switch node or switch network entity in the SS7 network that serves to originate, terminate, or tandem telephone calls by sending messages to other SSP's and/or SCP's.

Signaling Connection Control Part (SCCP)

The signaling layer in the SS7 protocol that provides a transfer capability for circuit related and non-circuit related signaling information.

Signaling System 7 (SS7)

A worldwide standard messaging format which defines the procedures and protocol used by network entities in the PTN network to exchange information over a digital out-of-band signaling network in order to setup, route, and control telephone calls and provide routing capabilities for wireless, Intelligent Network and other advanced services.

Signaling Transfer Point (STP)

A node or network entity in the SS7 network that serves as a packet switch and routes incoming messages based on routing information contained in an SS7 message. An STP may perform Global Title Translation.

Signaling Point (SP)

A network node in the SS7 network. It may be a signaling endpoint, signaling transfer point (STP), service switching point (SSP) or a service control point (SCP).

Simple TCAP Interworking Part (STIP)

A convergence protocol layer provided between the TCAP layer and the transport layer (e.g. TCP or UDP) in IP network, such that TCAP messages can be transported over the IP protocol layer in the IP network.

Subscriber

A customer who subscribes to telephony based services.

TCAP/IP Interworking Gateway (TIPG)

The network entity that provides a fully functional interface for exchanging TCAP messages between the PTN/SS7 network and the IP network, to support fully functional services interworking therebetween. The TIPG function can be a logical network entity resident within an interworking signaling gateway (ISG).

Transaction Capabilities Application Part (TCAP)

Transaction Capabilities in the SS7 protocol are functions that control non-circuit related information transfer between two or more signaling nodes executing applications via a signaling network. Queries and responses between SSPs and SCPs are carried in TCAP messages. In the SS7 protocol, TCAP uses SCCP routing and addressing functions to send and receive messaging data.

Transmission Control Protocol (TCP)

A worldwide standard messaging format or protocol used in the IP network comprising transport layer functions in the OSI model protocol stack.

Visitor Location Register (VLR)

A database maintained by the wireless telephony network in a given location area which temporarily stores the information required to establish telephone calls to/from a wireless telephone terminal in that location area serviced by the public telephone network.

PTN/IP Interworking Signaling Gateway Apparatus

The present invention provides an ISG (Interworking Signaling Gateway) apparatus for providing full signaling and services interworking between an IP network and a public telephone network, as shown in **Figures 1(b)** and **2.** **Figure 2(a)** illustrates an ISG gateway apparatus **100** for selectively interworking a PTN / SS7 network **10** and an IP network **20** according to the present invention. In one embodiment, the apparatus for selectively interworking comprises a first interface **110**, a second interface **120**, and a processor **130** operably connected to at least one of the first interface and the second interface. The PTN / SS7 network transmits and receives a message in a first format of a first type, such as an SS7 protocol format ISUP and/or TCAP message, while the IP network transmits and receives a message in a second format of a second type, such as an IP protocol format ISUP and/or TCAP message. The first interface **110** is adapted for communicating with the PTN / SS7 network, and as such, is adapted for exchanging messages in the first format of the first type with the PTN / SS7 network. The second interface **120** is adapted for communicating with the IP network, and as such, is adapted for exchanging messages in the second format of the second type with the IP network. The second interface is preferably but not necessarily adapted to exchange conventional TCP/IP messages with the IP network.

The processor **130** is adapted for translating the message in the first format of the first type received from the PTN / SS7 network into a message in the second format of the second type compatible with the IP network. The addressing and routing information in the message received from the PTN network in the first format is converted by the processor into addressing and routing information in a second format compatible with the IP network. As such, the translated message in the second format is forwarded by the processor to the IP network, and ultimately to a destination network node or entity. Preferably but not necessarily, the first format is an SS7 protocol format, while the second format is an IP protocol format. Preferably but not necessarily, the first type of message is an ISUP and/or TCAP message, while the second type of message is an encapsulated ISUP and/or TCAP message. Accordingly, the ISUP and/or TCAP message is preferably encapsulated in the IP protocol format by the processor for transmission in a compatible format to the IP network.

Similarly, the processor **130** may be further adapted for translating a message received from the IP or internet protocol network in the second format, such as an encapsulated message in the IP protocol format, and converting the IP network addressing and routing information in the received message into addressing and routing information in the first format compatible with the PTN or public telephone network. As such, the translated message in the first format is forwarded by the processor to the PTN network, and ultimately to a destination network node or entity. In essence, the encapsulation and message translation capabilities of the processor of the ISG apparatus are bidirectional and fully transparent between the respective networks and messaging formats. For example, **Figure 2(a)** shows bidirectional paths used for exchanging ISUP and TCAP messages between IP entities, such as **21** and **23**, and PTN network entities, such as **12, 14, 16,** and **18.** In essence, the ISG interworking apparatus **100** supports the exchange and transformation of ISUP and TCAP messages between the PTN network and IP network and their respective messaging formats, as shown in **Figure 2(c).**

The processor according to the present invention can be any microprocessor, microcontroller, or other computer processor capable of translating messages from one format to another. As such, the apparatus for selectively interworking can translate ISUP

and/or TCAP messages received from one of the IP network and the PTN / SS7 network, and forward a corresponding ISUP and/or TCAP message in the proper format to the other of the IP network and the PTN / SS7 network. The apparatus accordingly provides interworking capability between the internet protocol and PTN / SS7 network domains.

The apparatus for interworking may further comprise a storage memory 140 operably connected to the processor 130 such that the processor is responsive thereto. The storage memory can be used to store data and software application programs to be used by the processor. Further, the storage memory is used for maintaining addressing and routing information relating to one or more PTN / SS7 networks and one or more IP networks. The storage memory can be part of the processor, such as internal cache memory or RAM. Alternatively, the storage memory may be disposed outside the processor but operably connected thereto, such as an external RAM, Disk, cache RAM, EEPROM, or some combination of these storage devices, so long as addressing and routing data can be stored therein. More particularly, the storage memory can be organized to contain a table correlating a plurality of IP network node addresses and a plurality of PTN / SS7 network node addresses.

The processor 130 is used to remap an address of an incoming message received by one of the first interface and the second interface, prior to forwarding an outgoing message representative of the incoming message with a remapped address through the other of the first interface and the second interface. This is true whether the incoming message is an ISUP message or a TCAP message, and regardless of the originating network and corresponding format used therein. The addresses can be remapped inside the processor, or the processor may have to access the storage memory in order to remap the addresses. Preferably, each IP network node address may comprise an IP address and a port number. For instance, IP entity 21 and IP entity 23 are each assigned a unique IP node address in the IP network, consisting of an IP address and a port number. Each PTN / SS7 network node is assigned a signaling point code. For example, PTN / SS7 network nodes SCP 14, SP 18, and VLR/HLR 16 are each assigned a unique SS7 address in the PTN / SS7 network consisting of a signaling point code. In addition to the point codes, other information may be required for address conversion. For TCAP messages,

address conversion may require Global Title Translation (GTT) data and/or a Subsystem Number (SSN). For ISUP messages, a circuit identification code (CIC) is required to uniquely identify a media gateway (MG) that has trunking connections to the SP or Signaling Point, as shown in **Figure 1(c)**.

Addressing destination nodes in either network is managed by the processor **130** operating in conjunction with the addressing tables maintained in the storage memory **140** as described above. The addressing and routing translation required can vary according to the type of message involved, such as an ISUP message or a TCAP message, the network originating the message, and the network receiving the translated message. For ISUP messages, the address of a node is determined by a point code, such as an originating point code, and the circuit identification code. In the PTN / SS7 network, the well established SCCP Global Title Translation (GTT) function is used to determine the address of a destination node in the SS7 network for TCAP messages. Based on the address mapping data, the GTT determines a destination point code in the PTN / SS7 network for a given network node associated with a TCAP message. The interworking apparatus extends the global title addressing concept to apply to addressing IP network nodes as well by extending the address translation table to include IP node addresses, such as an IP address and a port number. The Global Title Translation (GTT) function provided by a software application program executing in the interworking apparatus determines the destination address of an IP network node from an incoming TCAP message received from the PTN / SS7 network. The address translation functions performed when a message is received from the IP network or PTN / SS7 network will be described below.

The processor **130** of the interworking apparatus can be adapted to perform various functions in the respective networks. The processor can be adapted to serve as a signaling end point for the PTN / SS7 network, that is, only this interworking network node needs to be assigned with an SS7 point code and is known to the PTN/SS7 network. In the PTN / SS7 network, the processor can be further adapted to provide signaling transfer point (STP) functions, such as GTT functions, in PTN / SS7 network. In addition, the processor can be adapted to serve as a transit signaling point for the IP network, and

provide GTT addressing and routing functions in the IP network. As such, the processor executes a software application program for carrying out these and other functions described herein.

Figures 3(a) and **3(b)** provide more details regarding the ISG interworking apparatus. Messaging formats supported by the ISG interworking apparatus in the IP network and public telephone network (PTN) interface are illustrated therein. **Figure 3(a)** illustrates messaging format translations for exchanging TCAP messages between the PTN network and the IP network. The processor of the ISG interworking apparatus **100** can be adapted to provide SCCP addressing and routing to the PTN / SS7 network, and addressing and routing similar to, or approximate to, SCCP addressing and routing to the IP network. The processor can be adapted to execute a STIP software application program for processing encapsulated TCAP messages exchanged with the IP network. The STIP protocol layer provides addressing similar to SCCP addressing when TCAP messages are transported over the IP protocol in the IP network. In addition, the processor can also be adapted to translate the TCAP message received from the PTN / SS7 network in the first format into a second format suitable for transmission to the IP network, without altering the TCAP characteristics of the incoming message, as shown in **Figure 3(a)**. For instance, the TCAP message **200** is transported in a first format **201** in the PTN / SS7 network, while the TCAP message **200** is transported in a second format **202** in the IP network, as shown.

Since the translated TCAP message is forwarded to the IP network, the destination IP network entity or network node in the IP network preferably also executes a compatible STIP software application. For example, as shown in **Figure 5**, STIP functions must be resident in the ISG interworking apparatus **100** and in the IP network entity **21**. As such, the translated TCAP messages received can be interpreted, while TCAP messages can be created and forwarded to the IP network and the interworking apparatus. The STIP software applications executing in the IP network entity and in the interworking apparatus could be identical, although this is not required. At a minimum, the STIP applications in the IP entity and interworking apparatus must work compatibly together.

As such, a TCAP message in the first format of the first type transmitted and received in the public telephone message comprises a TCAP portion 200, an SCCP portion 210, and an MTP portion 230, as shown. When the TCAP message is received from the PTN / SS7 network by the ISG interworking apparatus, the processor translates the TCAP message from the first format 201 into the second format 202, that is, into an encapsulated TCAP message format. The encapsulated TCAP message in the second format comprises a TCAP portion 200, a STIP portion 220, and an IP portion 250, at least. Further, the encapsulated TCAP message may further include a transport portion 240, such as TCP, UDP, or another IP protocol transport portion, disposed between the STIP portion and the IP portion to serve as a transport layer in the IP network. After translation by the processor, the encapsulated TCAP message is transmitted to the IP network to be forwarded to the corresponding IP network destination node.

Figure 3(b) illustrates messaging format translations for exchanging ISUP between the PTN network and the IP network. The processor included in the ISG interworking apparatus 100 can be adapted to convert ISUP/MTP addressing and routing according to the PTN / SS7 network, into IP network addressing and routing for transporting an ISUP message between the two respective networks. In addition, the processor can also be adapted to translate the ISUP message received from the PTN / SS7 network in the first format into a second format suitable for transmission to the IP network, without altering the ISUP characteristics of the incoming message, as shown in **Figure 3(b)**. Note that the SCCP layer in the SS7 protocol is not required in the ISUP messaging case because the ISUP layer is built directly on top of the MTP layer. For instance, the ISUP message 205 is transported in a first format 203 in the PTN / SS7 network, while the ISUP message 205 is transported in a second format 204 in the IP network, as shown. Since the translated ISUP message is forwarded to the IP network, the destination IP network entity or network node in the IP network preferably also executes a compatible software application program for extracting and interpreting ISUP messages. For example, as shown in **Figure 5**, ISUP message routing functions must be resident in the ISG interworking apparatus 100 and ISUP message processing functions must be resident in the IP network entity 21. As such, the translated ISUP messages

received can be interpreted, while ISUP messages can be created and forwarded to the IP network and the ISG interworking apparatus. The software application programs executing in the IP network entity and in the ISG interworking apparatus could be identical, although this is not required. At a minimum, the software application programs in the IP entity and interworking apparatus must work compatibly together.

Similarly, an ISUP message in the first format of the first type transmitted and received in the public telephone message comprises an ISUP portion **205** and an MTP portion **230**, as shown. When the ISUP message is received from the PTN / SS7 network by the ISG interworking apparatus, the processor translates the ISUP message from the first format **203** into the second format **204**, that is, into an encapsulated ISUP message format. The encapsulated ISUP message in the second format comprises an ISUP portion **205** and an IP portion **250**, at least. Further, the encapsulated ISUP message may further include a transport portion **240**, such as TCP, UDP, or another IP protocol transport portion, disposed between the ISUP portion and the IP portion to serve as a transport layer in the IP network. After translation by the processor, the encapsulated ISUP message is thereafter transmitted to the IP network to be forwarded to the corresponding IP network destination node.

The ISG interworking apparatus provides analogous translation capabilities for messages received in the second format from the IP network, whether the type of message received is an ISUP message or a TCAP message. Accordingly, the ISG interworking apparatus can transmit and receive ISUP and/or TCAP messages in the first format to/from the PTN network. Further, the ISG interworking apparatus can transmit and receive ISUP messages and/or TCAP messages in the second format to/from the IP network. The processor can receive an encapsulated ISUP or TCAP message in the second format from the IP network, and translate the received message into the first format suitable for transmission to the PTN / SS7 network, without altering the ISUP or TCAP characteristics of the incoming message. The encapsulated TCAP message received from the IP network has at least a TCAP portion, a STIP portion, and an IP protocol portion, while the encapsulated ISUP message has at least an ISUP portion and an IP protocol portion. In addition, the encapsulated ISUP or TCAP message may further

include a transport portion as described above, disposed between the ISUP or TCAP message portion and the IP protocol portion.

After an encapsulated ISUP or TCAP message is received from the IP network, the processor can translate the encapsulated ISUP or TCAP message into the first format suitable for transmission to the PTN / SS7 network. The translated TCAP message in the first format comprises at least a TCAP portion, an SCCP portion, and an MTP portion, whether or not the encapsulated TCAP message included a transport portion. The translated ISUP message in the first format comprises at least an ISUP portion and an MTP portion, whether or not the encapsulated ISUP message included a transport portion. Once translated by the processor, the formerly encapsulated ISUP or TCAP message is transmitted to the PTN / SS7 network to be forwarded to the corresponding destination node in the PTN / SS7 network.

Address translation processing must be performed by the processor on an incoming message received from one network in order to forward a representative message to the destination in other network. When an incoming TCAP message is received from the PTN / SS7 network, the IP network destination node address is determined by analyzing the destination point code (DPC) and the called party address (CdPA) of the incoming SS7 TCAP message. If the DPC is the ISG apparatus itself, the destination is a TCAP software application program executing in an IP network node, which can be an IP network entity or another ISG apparatus. The Routing Indicator in the Called Party Address (CdPA) is used to determine the ultimate destination node in the IP network. If a subsystem number (SSN) routing is available, the message is forwarded to the IP network entity having the same SSN. If Global Title routing is used, STIP performs the GTT translation to obtain the address of the destination ISG apparatus, and forwards the message there.

If the DPC is not the ISG apparatus itself, then the signaling transport function is requested. Thereafter, STIP retrieves the IP network node address, or IP address, of a far end ISG apparatus and forwards the message there. In addition, since a reply message caused by the forwarded message may need to returned to the originating network node in the PTN / SS7 network, the STIP application records the DPC with the incoming IP

address and port number when the message is sent to the far end ISG apparatus. Over time, old DPC/IP/port number entries in the address table are overwritten or "aged out" if not used as frequently as other entries in the address table. If the ISG apparatus is not the DPC, the SCCP Called Party Address (CdPA) and Calling Party Address (CgPA) fields from the incoming TCAP message received from the PTN / SS7 network are copied into the corresponding CdPA and CgPA fields in the STIP layer of the message to be forwarded to the IP network. However, if the SCCP CgPA field only contains a subsystem number, the DPC must be combined into the corresponding STIP CgPA field to permit the far end ISG apparatus to send the message to a PTN / SS7 network connected thereto. Also, if the SCCP CgPA field only contains a subsystem number, the OPC parameter from the incoming TCAP message must be combined into the corresponding STIP CgPA field to permit the response message to be sent back to the originating network node. The processor is advantageously applied to perform the aforementioned analysis and transformation of routing and addressing message parameters, as described.

When an incoming encapsulated TCAP message is received by the ISG apparatus, the destination node address in the PTN / SS7 network must be determined by the processor based on analysis of the received message. If the STIP CdPA (Called Party Address) indicates that Global Title routing is used, then Global Title Translation is performed by using the address translation table. If the destination address is an IP network address, then the message is forwarded on to the IP network entity. If the destination address is a point code in the PTN / SS7 network, then set the destination point code to the SS7 point code. That is, a TCAP message is sent from an application in IP network to an application in PTN/SS7 network. The STIP layer CdPA and CgPA fields from the encapsulated TCAP message received are copied into the SCCP layer CdPA and CgPA respectively. If the STIP CdPA field contains a point code explicitly and a subsystem number, the subsystem number is copied into the SCCP CdPA field and the point code is used as the destination point code for the MTP layer to route the message. If the STIP CdPA field indicates that Global Title routing is used, and the STIP CgPA field only contains a subsystem number, the message was originated from an IP

entity. In this case, STIP adds the point code associated with the receiving ISG apparatus into the SCCP CgPA field so that a response message can be sent back to the ISG apparatus, if needed.

As shown in **Figure 2(b)**, in one embodiment the ISG interworking apparatus **100** can support SS7 link and linkset features for both the PTN network and the IP network. Accordingly, the first interface **110** and second interface **120** are adapted to operate as an SS7 signaling link or linkset with the PTN network and as a pseudo-SS7 signaling link or linkset with the IP network respectively. As those skilled in the art will appreciate, SS7 links between two interconnected signaling points are called a linkset. SS7 networks require redundancy and diverse routes to provide reliable signaling transport. A combined linkset having two linksets between a signaling point and its interconnected STP pair provides a more reliable connection to the SS7 network since the signaling connection can be maintained under both link/linkset and a single processor failure conditions so long as at least one link within the linkset remains operational.

Accordingly, the ISG interworking apparatus supports links and/or linksets with each network through each respective interface. The ISG can serve as a signaling end point or as a signaling transfer point (STP) pair for the public telephone network. In addition, the ISG supports linksets of A-links, E-links, or both if the ISG is serving as a signaling end point. Further, the ISG supports linksets of A-links, E-links, and B-links/D-links if the ISG is serving as an STP pair to the interconnecting SS7 network. Further, the ISG interworking apparatus supports a pseudo SS7 A link/linkset and/or a pseudo SS7 E link/linkset with the IP network. The links and linksets supported with the IP network are referred to as "pseudo SS7" links and linksets because SS7 links are emulated through packetized ISUP and TCAP message transmissions over the IP protocol format through the IP network. In particular, the pseudo SS7 links are implemented in the IP protocol by remapping network addresses such that pseudo SS7 network point codes can be assigned to IP entities and/or to the ISG interworking apparatus. In effect, the pseudo SS7 links are created by provisioning functions within the ISG interworking apparatus.

The ISG interworking apparatus leverages its address remapping capabilities between the PTN network and IP network in order to generate and manage the pseudo SS7 links. Further, ISUP and TCAP messages are encapsulated and transported to/from the IP network over the pseudo SS7 links/linksets. One pseudo linkset is emulated between an IP entity and the ISG if the ISG is configured to operate as an SS7 signaling end point. A more reliable interconnection can be provided through emulation of a pseudo combined linkset between each IP entity and a pair of ISG apparatuses. The two IP paths comprising the pseudo combined linkset can then provide load-sharing or hot-standby functions to permit more reliable transport between the ISG apparatuses and the IP entities. The selection of a pseudo link (i.e. an IP network path) is one of the address remapping functions provided by the ISG apparatus.

Figures 4(a) and **4(b)** provide more details regarding an A link/linkset and/or an E link/linkset preferably provided by the ISG interworking apparatus. While the Figures show SS7 network implementations of the links for purposes of illustration, these links are substantially emulated in function and operation by the ISG interworking apparatus in the IP network. As shown in **Figure 4(a)**, an A link and/or linkset is used to interconnect an SS7 SEP (signaling end point) to a home or local STP (signaling transfer point). Among the possible SEP's that can be connected to an A link/linkset are an SCP (signaling control point), an SSP (service switching point), another ISG interworking apparatus operating as a signaling end point, an IP entity operating as a signaling end point (such as an IP server or a call server/call controller), or the like. In addition, the ISG interworking apparatus can emulate and operate as a signaling transfer point. In this case, the ISG is provisioned to operate as a mated pair of ISGs and connect links/linksets to SS7 network signaling end points, and/or other STP (service transfer point) pairs or equivalent network nodes. The operation and function of the SS7 A link/linkset is emulated over the IP protocol format in the IP network by the ISG interworking apparatus.

Figure 4(b) illustrates the E link/linkset. The dashed and broken lines between the SEP, SCP, and SSP in this Figure represent an inaccessible A link/linkset as previously described. The A link/linkset may be unavailable for many reasons, such as

network traffic and congestion, failure of the home STP pair for any reason, failure of the physical link interconnecting the SEP/SCP/SSP with the home STP pair, or the like. The SS7 protocol provides an E link/linkset between an SEP, SCP, or SSP as described above and a remote or backup STP pair, such that the E link/linkset can be used for signaling when the A link/linkset is temporarily or permanently unavailable for use. In practice, an SEP, SCP, and/or SSP can be connected to a home STP pair and to a remote STP pair, such that the signaling end point is still connected to the SS7 network despite the failure of either link/linkset. As such, the connection of the signaling end point to the SS7 network is highly reliable, despite the unavailability of a link/linkset and/or an STP. Similarly, the operation and function of the SS7 E link/linkset is emulated over the IP protocol format in the IP network by the ISG interworking apparatus.

It will be evident to those skilled in the art that the reliability of the IP network and IP entities therein will be substantially increased by leveraging the high reliability features of the SS7 protocol, links, and linksets in the IP network environment. More specifically, highly reliable IP network resources can be achieved through the SS7 link/linkset emulation provided by the ISG interworking apparatus. The present invention accordingly provides redundant paths and/or redundant IP resources such that more reliable services and signaling can be provided through the IP network. In addition, as shown in **Figures 5(a)** and **5(b)**, the IP network reliability can be further increased if an appropriate IP network configuration is implemented. **Figure 5(a)** shows one highly reliable network configuration according to the present invention, which leverages normal and pseudo SS7 links and linksets. As shown, redundant SS7 C links are provided between the two STP's, redundant SS7 A links are provided between each STP and either ISG interworking apparatus, and redundant pesudo SS7 A links are also provided between the ISG and each IP entity, such as an IP server or a call server/call controller. Further, redundant SS7 links can be provided to the SP or SCP as necessary.

In addition, the redundant SS7 and pseudo SS7 links are complimented by redundant network components therebetween as shown, such as dual STP's, dual ISG interworking apparatuses, and dual IP entities. In effect, the combination of redundant links and network components interfaces highly available resources from the IP network

to the highly reliable PTN / SS7 network. In addition, load sharing of signaling traffic can be provided by the processor of the ISG interworking apparatus between network nodes or entities in the IP network, PTN network, or both, thereby permitting message traffic to be distributed as desired. For example, one signaling message can be transmitted along the upper path to/from the primary IP entity, while the next signaling message can be transmitted along the lower path to/from the secondary IP entity. In this way, when one path is busy, the other path can be used to transfer signaling messages in a time-multiplexed manner, and vice versa. Higher availability and better network performance can be provided by load sharing. In addition, load sharing configurations are scalable such that higher performance can be provided by adding more network resources and network paths for dividing and sharing the processing of messaging traffic.

A redundant SS7 and pseudo SS7 network configuration can also provide higher availability through hot standby or active standby operation. The ISG interworking apparatus can also provide hot or active standby emulation for the IP network. Instead of allowing redundant network paths to time multiplex and share signaling messages, the processor in the ISG interworking apparatus can be adapted to forward a signaling message through two or more redundant paths. For example, a signaling message can be transmitted along the upper path to/from the primary IP entity and transmitted substantially simultaneously along the lower path to/from the secondary IP entity as shown in **Figure 5(a)**. Normally, the primary path and entity will process the signaling message. However, if the primary network entity or network path does not process the signaling message in a predetermined amount of time for any reason, the secondary entity will become active and process the message as a hot or active standby for the primary entity and path. The secondary path and entity will thereafter process signaling messages as the new default path and entity until and unless the primary network path and entity are restored into operation as the primary path and entity. This configuration provides very high availability since a signaling message is processed in parallel, while relatively little network performance gains are provided. The network configurations shown in **Figures 5(a)** and **5(b)** can be adapted to operate in load sharing or hot standby modes as desired.

Figure 5(b) illustrates other highly reliable PTN/IP network configurations that the ISG interworking apparatus can provide. Further, pseudo C links can be emulated and provided between two ISG interworking apparatuses, such as ISG' and ISG'' as shown. The pseudo C link permits messaging communication between two ISG interworking apparatuses such that they can work in unison, such as in load sharing or hot standby configurations. Accordingly, the ISG interworking apparatuses provide highly reliable signaling and services interworking between the PTN network and IP network. Still further, one or more ISG apparatuses can be configured in a highly reliable pseudo A link/linkset and pseudo E link/linkset configuration with one or more IP entities as shown. The failure bypass operation of the SS7 A link and E link as described previously is therefore provided by the ISG interworking apparatus and complimentary IP entity. The processor of the ISG interworking apparatus 100 can be adapted to reroute a signaling message received from the public telephone network or the internet protocol network to a backup network destination in the other respective network. The signaling message is rerouted to the backup network destination or entity when the signaling message cannot be delivered to the intended primary network destination of the signaling message. However, since network components and paths are preferably configured redundantly, the backup network destination or entity can either process the message for the primary network destination, or further reroute the message to the primary network destination through another available network path.

The present invention also provides another apparatus for providing signaling and service interworking between the PTN / SS7 network and the IP network. The apparatus for interworking comprises means for communicating with the PTN / SS7 network, means for communicating with the IP network, and means for translating messages into different formats. The means for communicating with the PTN / SS7 network, such as the aforementioned first interface or the like, is adapted to exchange ISUP messages and TCAP messages over the SS7 protocol with the PTN / SS7 network. In addition, the means for communicating with the IP network, such as the aforementioned second interface or the like, is adapted to exchange encapsulated ISUP messages and encapsulated TCAP messages over the IP protocol format with the IP network. The

means for translating messages, such as the aforementioned processor or the like, is adapted to receive an ISUP message or a TCAP message in the SS7 protocol format from the PTN / SS7 network, and to forward an encapsulated ISUP message or an encapsulated TCAP message in the IP protocol format to the IP network. Further, the apparatus for interworking may further comprise means for translating an encapsulated ISUP message or encapsulated TCAP message received from the IP network and correspondingly forwarding an ISUP message or a TCAP message in the SS7 protocol to the PTN / SS7 network. Functionally, the apparatus for interworking includes all the networking, translating, and processing capability of the aforementioned interworking apparatus.

In operation, the interworking apparatus will receive an incoming message, such as an ISUP or TCAP message, from one of the two interconnected networks. The format of the incoming message is analyzed by the processor to determine the originating network and network node, the destination network and network node, and what message processing will be required in order forward a message in the appropriate format to the ultimate destination node. As described, the incoming ISUP or TCAP message will be translated by the processor, such as by encapsulating or decapsulating the incoming message, such that the addressing, routing, and message format are correct for the network to which the ISUP or TCAP message will be forwarded. The processor will then forward the message to the corresponding network interface, and eventually to the destination network node. Thereafter, the interworking apparatus is adapted to receive a reply or return message from the destination network node, translate the reply or return message into the proper format, and forward the reply or return message back to the originating network node.

IP Entity Apparatuses

The present invention provides compatible IP network nodes or entities adapted for exchanging encapsulated ISUP messages and/or encapsulated TCAP messages with the IP network and/or the ISG interworking apparatus. The IP network is adapted to transmit and receive the second type of message in the second format, as discussed.

Therefore, an IP network entity apparatus complimentary in function to the ISG interworking apparatus is required, such that ISUP and/or TCAP messages in the second format can be exchanged and mutually interpreted so as to provide full interworking. The interrelationship between the ISG interworking apparatus and the complimentary IP entity apparatus is shown in **Figure 6**. The present invention provides an IP entity apparatus 21 for exchanging encapsulated ISUP and encapsulated TCAP messages with the IP network comprising a first interface for communicating with the IP network and a processor 22 operably connected to the first interface. The IP entity apparatus can be any IP entity suitable for processing, such as an IP server, an IP services server, a call server/ call controller, or the like. The first interface 25 of the apparatus is adapted to communicate with the IP network 20, and exchange encapsulated ISUP messages and encapsulated TCAP messages in the second format with the IP network. In one embodiment, the second format is an IP protocol format and the second type of message is an encapsulated ISUP message or an encapsulated TCAP message. For instance, the TCAP message 200 and STIP portion 220 overlying the transport portion 240 and the IP protocol 250 could comprise the second type of message in the second format respectively. For example, the ISUP message 205 overlying the transport portion 240 and the IP protocol 250 could also comprise the second type of message in the second format. In addition, the first interface may be adapted to exchange conventional TCP/IP messages with the IP network, such as in the IP protocol format.

The processor 22, being operably connected to the first interface 25, is adapted to extract a TCAP message from an encapsulated TCAP message in the second format received from the IP network. The processor is also adapted to extract an ISUP message from an encapsulated ISUP message in the second format from the IP network. Further, the processor is adapted to encapsulate a TCAP message or ISUP message and forward the encapsulated TCAP message or ISUP message in the second format to the IP network through the first interface. As such, encapsulated TCAP messages, encapsulated ISUP messages, and conventional IP messages can be exchanged between the apparatus and the IP network as shown. The processor of the IP entity apparatus is therefore adapted to encapsulate, decapsulate, create, or extract, TCAP and/or ISUP messages in either the

first format or the second format. The apparatus may further include a storage memory **24** as described above operably connected to the processor, for storing data, network related information, and/or software application programs. In one advantageous embodiment, the processor can be adapted to execute one or more TCAP software application programs. As such, TCAP messages received by the apparatus can be processed by the application program, and TCAP messages can be originated by the TCAP application program and transmitted to the IP network.

In addition, the processor can be adapted to execute a STIP software application program, as shown, such that SCCP primitives can be provided to the TCAP software application in order to send and receive TCAP messages therewith. The STIP software application program can be identical to the STIP software executed by the ISG interworking apparatus **100**, if desired. However, the only requirement is that the STIP software application program executed by the IP entity apparatus **21** be compatible with the STIP software application program executed by the ISG interworking apparatus. STIP provides addressing and routing functions for TCAP applications executing in the IP entity apparatus. The addressing and routing used is the same as that provided by the STIP software application program within an ISG interworking apparatus. However, since the IP entity apparatus **21** is not an SS7 network entity, although the IP entity apparatus may be assigned with an SS7 address in order to operate as a pseudo signaling point, the routing and addressing function in the IP entity apparatus does not require an SS7 point code and therefore does not utilize any point code sent to it from an ISG interworking apparatus. In addition, STIP executing in the IP entity apparatus provides the same three SCCP primitives provided by the SS7 network to a TCAP application, such as N-UNITDATA request, N-UNIT DATA indication, and N-NOTICE indication primitives. Since telephony services can be provided by exchanging TCAP messages, the processor may accordingly be further adapted to provide telephony services to the IP network and to an interworked PTN / SS7 network by exchanging encapsulated TCAP messages with the IP network.

When incoming encapsulated TCAP messages are received by the IP entity apparatus 21, the routing indicator in the CdPA STIP field must be set to subsystem number routing by the processor. The message is then passed to the TCAP application using the N-UNITDATA indication primitive with CdPA, CgPA, and TCAP data parameters. When outgoing messages are to be sent from the IP entity apparatus 21, the STIP software application program executed by the processor obtains data parameters from the TCAP application using the N-UNITDATA request primitive with CdPA, CgPA, and TCAP data parameters. The addressing information added to the outbound TCAP message comprises either a destination point code and a subsystem number (from the STIP CgPA field of the received message) or a Global Title. The TCAP application executed by the processor may or may not provide CgPA, so the CgPA is defined to be the same subsystem number as that is assigned to the TCAP application. Eventually, STIP uses the processor to forward the message in the second message format to some interconnected ISG interworking apparatus.

In another advantageous embodiment, the processor can be adapted to execute an ISUP software application program. As such, ISUP messages received by the apparatus can be processed by the application program, and ISUP messages can be originated by the ISUP call processing application program and transmitted to the IP network. In addition, the IP entity apparatus can emulate pseudo SS7 links, such as the aforementioned pseudo A links and pseudo E links, and participate in signaling with the ISG interworking apparatus as discussed above. As such, the IP entity apparatus can provide load sharing, hot or active standby, failover switching, and link switching. In addition, the processor within the IP entity apparatus may be adapted to execute a software application program to operate as an SS7 signaling end point, an SS7 service switching point, an SS7 service control point, and/or an SS7 call server/call controller.

The present invention further provides an apparatus for exchanging signaling messages with the IP network comprising means for communicating with the IP network and means for translating. The means for communicating with the IP network, such as the aforementioned second interface of the interworking apparatus or the like, is adapted to exchange encapsulated ISUP messages and encapsulated TCAP messages over the IP

protocol with the IP network. The means for translating, such as the aforementioned processor or the like, is operably connected to the means for communicating, and is adapted to extract an ISUP message and TCAP message respectively from an encapsulated ISUP message and an encapsulated TCAP message received from the IP network through the means for communicating. The means for translating is further adapted to encapsulate an ISUP message and a TCAP message, and thereafter forward an encapsulated ISUP message and an encapsulated TCAP message to the IP network through the means for communicating. Thus, the apparatus can exchange encapsulated ISUP messages and encapsulated TCAP messages with the IP network. Functionally, the apparatus for exchanging signaling messages includes all the networking, translating, and processing capability of the earlier mentioned IP entity apparatus **21** for exchanging encapsulated ISUP and encapsulated TCAP messages with the IP network.

In operation, the IP entity apparatus and/or apparatus for exchanging signaling messages will receive an encapsulated ISUP message or an encapsulated TCAP message from an ISG interworking apparatus through the IP network. The incoming message is analyzed to determine what message processing will be required. As described, the incoming encapsulated TCAP message will preferably be processed and utilized by a TCAP application, such as calling card billing verification. In addition, the TCAP application can originate a message to be sent to an ISG interworking apparatus. The STIP application is used to retrieve and format the outbound TCAP message. Thereafter, an encapsulated TCAP message may be forwarded to an ISG interworking apparatus through the IP network. In addition, an incoming encapsulated ISUP message will preferably be processed and utilized by an ISUP call processing application to establish a call connection. In addition, the ISUP application can originate a message to be sent to an ISG interworking apparatus.

IP/PTN Interworking Systems

The present invention provides various systems for providing signaling and service interworking between the public telephone network and the IP network. As such, the present invention provides a system interworking services and signaling between a

public telephone network and an IP network, comprising a first network node, a second network node, and at least one interworking apparatus operably connected to at least one of the first network node and the second network node. The first network node is operably connected to a public telephone network, while the second network node is operably connected to an internet protocol network. For the system example shown in **Figure 6**, the first network node could comprise a PTN network node **13**, the second network node could comprise an IP entity apparatus **21**, such as a call server/call controller or an IP services server, and the interworking apparatus could comprise an ISG interworking apparatus **100**. **Figures 5(a)** and **5(b)** show other examples of systems according to the present invention. Of course, those skilled in the art realize that many other systems according to the present invention could be created by using the teachings and descriptions provided herein.

As described, a system for providing services and signaling interworking between a public telephone network and an internet protocol network includes at least one interworking apparatus, such as the aforementioned ISG interworking apparatus **100**. The interworking apparatus of the system comprises a first interface for communicating with a public telephone network, adapted to exchange ISUP messages and TCAP messages in a first format with a public telephone network. In addition, the interworking apparatus comprises a second interface for communicating with an internet protocol network, adapted to exchange encapsulated ISUP messages and encapsulated TCAP messages with an internet protocol network. Further, the interworking apparatus includes a processor operably connected to the first and second interfaces. The processor is adapted to extract an ISUP message and/or a TCAP message in the first format received from a public telephone network, and further adapted to forward a representative encapsulated message containing an ISUP message and/or a TCAP message respectively in the second format to an internet protocol network. The processor is further adapted to translate an encapsulated message containing an ISUP message and/or a TCAP message in the second format received from an internet protocol network, and adapted to forward an ISUP message and/or a TCAP message in the first format to a public telephone

network. Preferably but not necessarily, the first format is an SS7 protocol format, while the second format is an IP protocol format.

In one embodiment of the system, the first network node comprises part of the public telephone network, and is operably connected to the first interface. In addition, the second network node of the system comprises part of the IP network, and is operably connected to the second interface. The first network node and second network node in different network domains are connected to, and through, at least one interworking apparatus. Accordingly, this system establishes communications and interworking between a network node in the IP network and a network node in the public telephone network. In a further embodiment of the system, the first network node and second network node each further comprise a processor. In this case, when the first format is an SS7 protocol format, the processor in the first network node is adapted to exchange ISUP and/or TCAP messages in the SS7 protocol with at least one interworking apparatus. Further, the processor in the second network node is adapted to exchange encapsulated ISUP and/or encapsulated TCAP messages with at least one interworking apparatus. The first network node and second network node in different network domains can thereby exchange ISUP and/or TCAP messages through at least one interworking apparatus.

Further, each processor can be adapted to execute a TCAP application software program, such that the TCAP application software programs in the first network node and in the second network node can communicate through at least one interworking apparatus. As described above, advanced services can be established to utilize service infrastructures in different network domains because TCAP messages are transported efficiently across network domains by the interworking apparatus. In addition, each processor can be adapted to execute an ISUP application software program, such that the ISUP application software programs in the first network node and in the second network node can communicate through at least one interworking apparatus. As described above, reliable signaling and SS7 link emulation can thereby be established to utilize resources in different network domains because ISUP and TCAP messages are transported efficiently across network domains by the interworking apparatus.

One embodiment of the system for interworking services and signaling between the public telephone network and the IP network comprises a first interworking apparatus and a second interworking apparatus. See **Figures 5(a)** and **5(b)** for two examples of this system embodiment. Of course, those skilled in the art will understand that numerous other system configurations utilizing two or more interworking apparatuses can be defined within the spirit of the present invention. The first interworking apparatus and second interworking apparatus are operably connected to each other, such that messages can be exchanged therebetween. For example, the first and second interworking apparatuses in **Figure 5(b)** can communicate through an IP path, such as a pseudo C link. In addition, at least one of the first interworking apparatus and the second interworking apparatus is connected to the first network node. For example, in **Figure 5(a)** each STP **12** is operably connected to each ISG interworking apparatus **100** as shown. Further, at least one of the first interworking apparatus and the second interworking apparatus is connected to the second network node. For example, in **Figure 5(a)** each IP entity **21** is operably connected to each ISG interworking apparatus **100** as shown. Accordingly, the interconnections permit messages to be exchanged between the first network node and the second network node through the operably connected interworking apparatuses. By analogy, the same aforementioned capability is provided by the interconnected interworking apparatuses interconnected between PTN network nodes and IP network nodes shown in the example system of **Figure 5(b)**.

The system comprising first and second interworking apparatuses includes further embodiments. The first and second interworking apparatuses can be adapted to emulate one or more pseudo SS7 links in the IP network, such as an A link, E link, C link, or the like. As such, the respective SS7 signaling link can be emulated for interfacing with the second network node through the IP network. Accordingly, the first and second apparatuses can be adapted to emulate at least one SS7 network reliability function, such as load sharing, active standby operation, primary/backup operation, network node bypass, and failover operations between the second network node and the first and second interworking apparatuses. Therefore, high reliability signaling and services can be provided from the IP network and IP entities resident therein. Further, the second

network node can be adapted to execute a software application program to operate as a signaling end point, a service switching point, a service control point, a call server/call controller, or the like. The second network node can operate as one or more of the aforementioned as desired.

In one further embodiment, the present invention provides a system for providing signaling and service interworking between the public telephone network and the IP network comprising a first network node, a second network node, and at least one interworking apparatus operably connected to at least one of the first network node and the second network node. The first network node is operably connected to a public telephone network, while the second network node is operably connected to an internet protocol network. In this embodiment, each interworking apparatus further comprises means for communicating with the public telephone network, means for communicating with the IP network, and means for translating. The means for communicating with the public telephone network, such as the aforementioned first interface or the like, is adapted to exchange ISUP and/or TCAP messages over the SS7 protocol format with the public telephone network. In addition, the means for communicating with the IP network, such as the aforementioned second interface or the like, is adapted to exchange ISUP messages and/or TCAP messages over the IP protocol format with the IP network. The means for translating, such as the aforementioned processor or the like, is operably connected to at least one of the means for communicating with the public telephone network and the means for communicating with the IP network. Further, the means for translating is adapted to translate an ISUP message and/or a TCAP message received in the SS7 protocol format from the public telephone network, and thereafter forward a representative encapsulated ISUP message and/or encapsulated TCAP message over the IP protocol format to the IP network. The means for translating is also adapted to translate an encapsulated ISUP message and/or an encapsulated TCAP message from the IP network, and thereafter forward an ISUP message and/or a TCAP message in the SS7 protocol format to the public telephone network. Functionally, the interworking apparatus of this system includes all the networking, translating, and processing

capability of the aforementioned ISG interworking apparatuses and other related aforementioned interworking apparatuses.

Signaling Interworking Method

The present invention likewise provides a method for providing signaling interworking between the public telephone network and the IP network. The method provided by the present invention initially comprises the step of receiving at least one of an ISUP message and a TCAP message in a first format, such as an SS7 protocol format, from the public telephone network. Next, the method comprises the steps of extracting at least one of the ISUP message and the TCAP message respectively from the first format, and thereafter encapsulating at least one of the ISUP message and the TCAP message respectively in a second format, such as an IP protocol format. As such, at least one of the ISUP message and the TCAP message can be forwarded to the IP network to permit signaling interworking therethrough. Preferably, the first protocol format is an SS7 protocol format, while the second format is an IP protocol format.

In one embodiment, the method may further comprise the step of transmitting at least one of the encapsulated ISUP message and the encapsulated TCAP message to a network node in the IP network, after the encapsulating step. Further, the method may include the step of decapsulating at least one of the encapsulated ISUP message and the encapsulated TCAP message received by the network node in the IP network, to thereby respectively permit recovery of at least one of the original ISUP message and the original TCAP message. A further embodiment of the method further comprises the steps of encapsulating at least one of an ISUP message and a TCAP message, and transmitting at least one of the encapsulated ISUP message and the encapsulated TCAP message in the first protocol format, such as an SS7 protocol format, to the public telephone network, after the decapsulating step.

Accordingly, the present invention provides apparatuses, systems, and related methods for providing reliable signaling and service interworking between a public telephone network and an internet protocol network. As such, the vast resources located

in internet protocol networks can be leveraged advantageously by the public telephone network, while preserving the very high level of reliability expected in the PTN network.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed herein and that modifications and other embodiments are intended to be included within the scope of the appended claims which define the present invention. Further, while the different embodiments of the present invention are separated by headings for purposes of organization and readability, all aspects of the specification and descriptions of the present invention provided above are to be considered collectively for interpreting the present invention as claimed below.

WHAT IS CLAIMED IS:

1. An apparatus for providing signaling and service interworking between a public telephone network and an internet protocol network, wherein the public telephone network transmits and receives a message in a first format of a first type and the internet protocol network transmits and receives a message in a second format of a second type, and wherein the apparatus comprises:

a first interface for communicating with the public telephone network, said first interface adapted to exchange messages in the first format of the first type with the public telephone network;

a second interface for communicating with the internet protocol network, said second interface adapted to exchange messages in the second format of the second type with the internet protocol network; and

a processor, operably connected to at least one of said first interface and said second interface, wherein said processor is adapted for translating the message received in the first format from the public telephone network into the second format, such that public telephone network addressing and routing information in the message received is converted for the internet protocol network, and wherein said processor is adapted for forwarding the message encapsulated in the second format to the internet protocol network, such that signaling and service interworking can thereby be provided by exchanging messages between the public telephone network and the internet protocol network.

2. The apparatus according to Claim 1, wherein said processor is further adapted for translating the message received from the internet protocol network in the second format, such that internet protocol network addressing and routing information in the message received is converted for the public telephone network, and wherein said processor is adapted for forwarding the message in the first format to the public telephone network.

3. The apparatus according to Claim 1, wherein the first format translated by said processor is an SS7 protocol format, and wherein the second format translated by said processor is an IP protocol format.

4. The apparatus according to Claim 1, wherein said first interface is adapted to exchange TCAP messages with the public telephone network, wherein said second interface is adapted to exchange TCAP messages with the internet protocol network, wherein the first type of message is an SS7 TCAP message, and wherein the second type of message is an encapsulated TCAP message.

5. The apparatus according to Claim 1, wherein said first interface is adapted to exchange ISUP messages with the public telephone network, wherein said second interface is adapted to exchange ISUP messages with the internet protocol network, wherein the first type of message is an SS7 ISUP message, and wherein the second type of message is an encapsulated ISUP message.

6. The apparatus according to Claim 1, further comprising a storage memory operably connected to said processor for maintaining addressing and routing information relating to the public telephone network and the internet protocol network.

7. The apparatus according to Claim 6, wherein the storage memory contains a table correlating a plurality of internet protocol network node addresses and a plurality of public telephone network signaling node addresses, and wherein said processor is responsive to said storage memory for remapping an address of an incoming signaling message received into one of said first interface and said second interface, prior to forwarding an outgoing signaling message representative of the incoming message with a remapped address through the other of said first interface and said second interface.

8. The apparatus according to Claim 7, wherein each internet protocol network node address stored in said storage memory comprises an IP address and a port number, and wherein each public telephone network node address stored in said storage memory comprises a point code and a circuit identification code, for permitting said processor to convert ISUP messages received from at least one of the public telephone network and the internet protocol network into a format compatible with the other of the public telephone network and the internet protocol network.

9. The apparatus according to Claim 7, wherein each internet network node address stored in said storage memory comprises an IP address and a port number, and wherein each public telephone network node address stored in said storage memory comprises a destination point code and a subsystem number, for permitting said processor to convert TCAP messages received from at least one of the public telephone network and the internet protocol network into a format compatible with the other of the public telephone network and the internet protocol network.

10. The apparatus according to Claim 6, wherein said processor is adapted to serve as a signaling end point for the public telephone network.

11. The apparatus according to Claim 6, wherein said processor is further adapted to serve as a signaling transfer point to the public telephone network.

12. The apparatus according to Claim 7, wherein said processor and said first interface are adapted to operate as one or more SS7 signaling links selected from the group consisting of an A link, a B link, a D link, and an E link for interfacing with the public telephone network.

13. The apparatus according to Claim 12, wherein said processor and said second interface are adapted to operate as one or more pseudo SS7 signaling links selected from the group consisting of an A link and an E link, so as to emulate the respective SS7 signaling for interfacing with the internet protocol network.

14. The apparatus according to Claim 13, wherein said processor is further adapted to exchange signaling messages with the public telephone network and the internet protocol network such that load sharing of signaling messaging traffic can be provided by said processor between network entities in at least one of the public telephone network and the internet protocol network.

15. The apparatus according to Claim 13, wherein said processor is further adapted to exchange signaling messages with the public telephone network and the internet protocol network such that hot standby processing of signaling messaging traffic can be provided by said processor between network entities in at least one of the public telephone network and the internet protocol network.

16. The apparatus according to Claim 13, wherein said processor is further adapted to reroute a signaling message received from one of the public telephone network and the internet protocol network to a backup network destination entity in the other of the public telephone network and the internet protocol network when the signaling message cannot be delivered to a primary network destination entity.

17. An apparatus for exchanging signaling messages with an internet protocol network, wherein the internet protocol network is adapted to transmit and receive messages in a second format of a second type, and wherein the apparatus comprises:

a first interface for communicating with the internet protocol network, said first interface adapted to exchange messages in the second format of the second type with the internet protocol network; and

a processor operably connected to said first interface, wherein said processor is adapted for processing a message of the second type encapsulated in the second format received from the internet protocol network through said first interface, and wherein said processor is further adapted to forward a message of the second type in the second format to the internet protocol network, such that signaling and service interworking can thereby be provided by exchanging encapsulated messages with the internet protocol network.

18. The apparatus according to Claim 17, wherein the second format translated by said processor is an IP protocol format for encapsulating the message of the second type therein.

19. The apparatus according to Claim 18, wherein the message of the second type translated by said processor comprises at least one of an encapsulated TCAP message and an encapsulated ISUP message.

20. The apparatus according to Claim 19, wherein said processor and said first interface are adapted to operate as one or more pseudo SS7 signaling link selected from the group consisting of an A link and an E link, so as to emulate the respective SS7 signaling link for interfacing with the internet protocol network.

21. The apparatus according to Claim 20, wherein said processor is adapted to execute a software application program to operate as at least one of a signaling end point, a service switching point, a service control point, and a call server/call controller.

22. A system for providing signaling and service interworking between a public telephone network and an internet protocol network, comprising:

a first network node, operably connected to the public telephone network;

a second network node, operably connected to the internet protocol network; and

at least one interworking apparatus, operably connected to at least one of said first network node and said second network node, wherein each interworking apparatus further comprises:

a first interface for communicating with the public telephone network, said first interface adapted to exchange ISUP messages and TCAP messages in a first format with the public telephone network;

a second interface for communicating with the internet protocol network, said second interface adapted to exchange ISUP messages and TCAP messages in a second format with the internet protocol network; and

a processor, operably connected to said first interface and said second interface, wherein said processor is adapted for extracting at least one of an ISUP message and a TCAP message received in the first format from the public telephone network and forwarding an encapsulated message containing at least one of an ISUP message and a TCAP message in the second format to the internet protocol network, and wherein said processor is adapted for translating an encapsulated message containing at least one of an ISUP message and a TCAP message in the second format received from the internet protocol network and forwarding at least one of an ISUP message and a TCAP message in the first format to the public telephone network.

23. The system according to Claim 22, wherein the first format translated by said processor is an SS7 protocol format, and wherein the second format translated by said processor is an IP protocol format.

24. The system according to Claim 22, wherein said first network node comprises part of the public telephone network and is operably connected to said first interface, and wherein said second network node comprises part of the internet protocol network and is operably connected to said second interface, such that said first network node and said second network node are each connected to said at least one interworking apparatus and can communicate therethrough.

25. The system according to Claim 24, wherein said first network node and said second network node each comprise a processor, wherein the first format is an SS7 protocol format, wherein the processor of said first network node is adapted to exchange at least one of an ISUP message and a TCAP message in the SS7 protocol with said at least one interworking apparatus, and wherein the processor of said second network node is adapted to exchange encapsulated messages containing at least one of an ISUP message and a TCAP message with said at least one interworking apparatus, such that said first network node and said second network node can exchange at least one of an ISUP message and a TCAP message through said at least one interworking apparatus.

26. The system according to Claim 25, wherein each processor is adapted to execute a TCAP application software program, such that the TCAP application software programs in said first network node and said second network node can communicate through said at least one interworking apparatus and exchange telephony services.

27. The system according to Claim 26, wherein each processor is adapted to execute an ISUP application software program, such that the ISUP application software programs in said first network node and said second network node can communicate through said at least one interworking apparatus and exchange telephony signaling.

28. The system according to Claim 22, comprising a first interworking apparatus and a second interworking apparatus, wherein said first interworking apparatus and said second interworking apparatus is operably connected to each other such that messages are exchanged therebetween, wherein at least one of said first interworking apparatus and said second interworking apparatus is further operably connected to said first network node, wherein at least one of said first interworking apparatus and said second interworking apparatus are further operably connected to said second network node, such that messages can be exchanged between said first network node and said second network node through the operably connected interworking apparatuses.

29. The system according to Claim 28, wherein said first interworking apparatus and said second interworking apparatus are adapted to emulate at least one pseudo SS7 signaling link selected from the group consisting of an A link and an E link, so as to emulate the respective SS7 signaling link for interfacing with said second network node through the internet protocol network.

30. The system according to Claim 28, wherein said first interworking apparatus and said second interworking apparatus are adapted to emulate at least one SS7 network reliability function selected from the group consisting of load sharing, active standby operation, primary/backup operation, network node bypass, and failover operations between said second network node and said first and second interworking apparatuses.

31. The system according to Claim 30, wherein said second network node further comprises a processor executing a software application program, such that said second network node is adapted to operate as at least one of a signaling end point, a service switching point, a service control point, and a call server/call controller.

32. An apparatus for providing signaling and service interworking between a public telephone network and an internet protocol network, comprising:

means for communicating with the public telephone network, wherein said means for communicating with the public telephone network is adapted to exchange at least one of an ISUP message and a TCAP message over the SS7 protocol format with the public telephone network;

means for communicating with the internet protocol network, wherein said means for communicating with the internet protocol network is adapted to exchange at least one of an encapsulated ISUP message and an encapsulated TCAP message over the IP protocol format with the internet protocol network; and

means for translating at least one of the ISUP message and the TCAP message in the SS7 protocol format received from the public telephone network and respectively forwarding at least one of the encapsulated ISUP message and the encapsulated TCAP message in the IP protocol format to the internet protocol network.

33. The apparatus according to Claim 32, further comprising means for translating at least one of an encapsulated ISUP message and an encapsulated TCAP message received from the internet protocol network and respectively forwarding at least one of an ISUP message and a TCAP message in the SS7 protocol to the public telephone network.

34. A system for providing signaling and service interworking between a public telephone network and an internet protocol network, comprising:

a first network node, operably connected to the public telephone network;

a second network node, operably connected to the internet protocol network; and

at least one interworking apparatus, operably connected to at least one of said first network node and said second network node, wherein each interworking apparatus further comprises:

means for communicating with the public telephone network adapted to exchange ISUP messages and TCAP messages over the SS7 protocol format with the public telephone network;

means for communicating with the internet protocol network adapted to exchange encapsulated ISUP messages and encapsulated TCAP messages over the IP protocol format with the internet protocol network; and

means for translating, operably connected to at least one of said means for communicating with the public telephone network and said means for communicating with the internet protocol network, wherein said means for translating is adapted to translate at least one of an ISUP message and a TCAP message received in the SS7 protocol format from the public telephone network, and adapted to respectively forward at least one of an encapsulated ISUP message and an encapsulated TCAP message in the IP protocol format to the internet protocol network.

35. The system according to Claim 34, wherein said means for translating is adapted to translate at least one of an encapsulated ISUP message and an encapsulated TCAP message in the IP protocol format received from the internet protocol network and respectively forward at least one of an ISUP message and a TCAP message in the SS7 protocol format to the public telephone network.

36. An apparatus for exchanging signaling messages with an internet protocol network, comprising:

means for communicating with the internet protocol network adapted to exchange at least one of an encapsulated ISUP message and an encapsulated TCAP message over the IP protocol format with the internet protocol network; and

means for translating, operably connected to said means for communicating and adapted to extract at least one of an ISUP message and a TCAP message from at least one of an encapsulated ISUP message and an encapsulated TCAP message received from the internet protocol network through said means for communicating, and wherein said means for translating is further adapted to encapsulate at least one of an ISUP message and a TCAP message and respectively forward at least one of an encapsulated ISUP message and an encapsulated TCAP message to the internet protocol network through said means for communicating, such that encapsulated ISUP and TCAP messages of can be exchanged with the internet protocol network.

37. A method for providing signaling interworking between a public telephone network and an internet protocol network, comprising the steps of:

receiving at least one of an ISUP message and a TCAP message from the public telephone network in an SS7 protocol format;

extracting at least one of the ISUP message and the TCAP message from the SS7 protocol format; and

encapsulating at least one of the ISUP message and the TCAP message in an IP protocol format, such that at least one of the ISUP message and the TCAP message can respectively be forwarded to the internet protocol network to permit signaling interworking therethrough.

38. The method according to Claim 37, further comprising the step of transmitting at least one of the encapsulated ISUP message and the encapsulated TCAP message in the IP protocol format to a network node in the internet protocol network, after said encapsulating step.

39. The method according to Claim 38, further comprising the step of decapsulating at least one of the encapsulated ISUP message and the encapsulated TCAP message in the IP protocol format received by the network node in the internet protocol network, to respectively permit recovery of at least one of the original ISUP message and the original TCAP message.

40. The method according to Claim 39, further comprising the step of forwarding at least one of the received ISUP message and the received TCAP message in the SS7 protocol format to the public telephone network, after said decapsulating step.

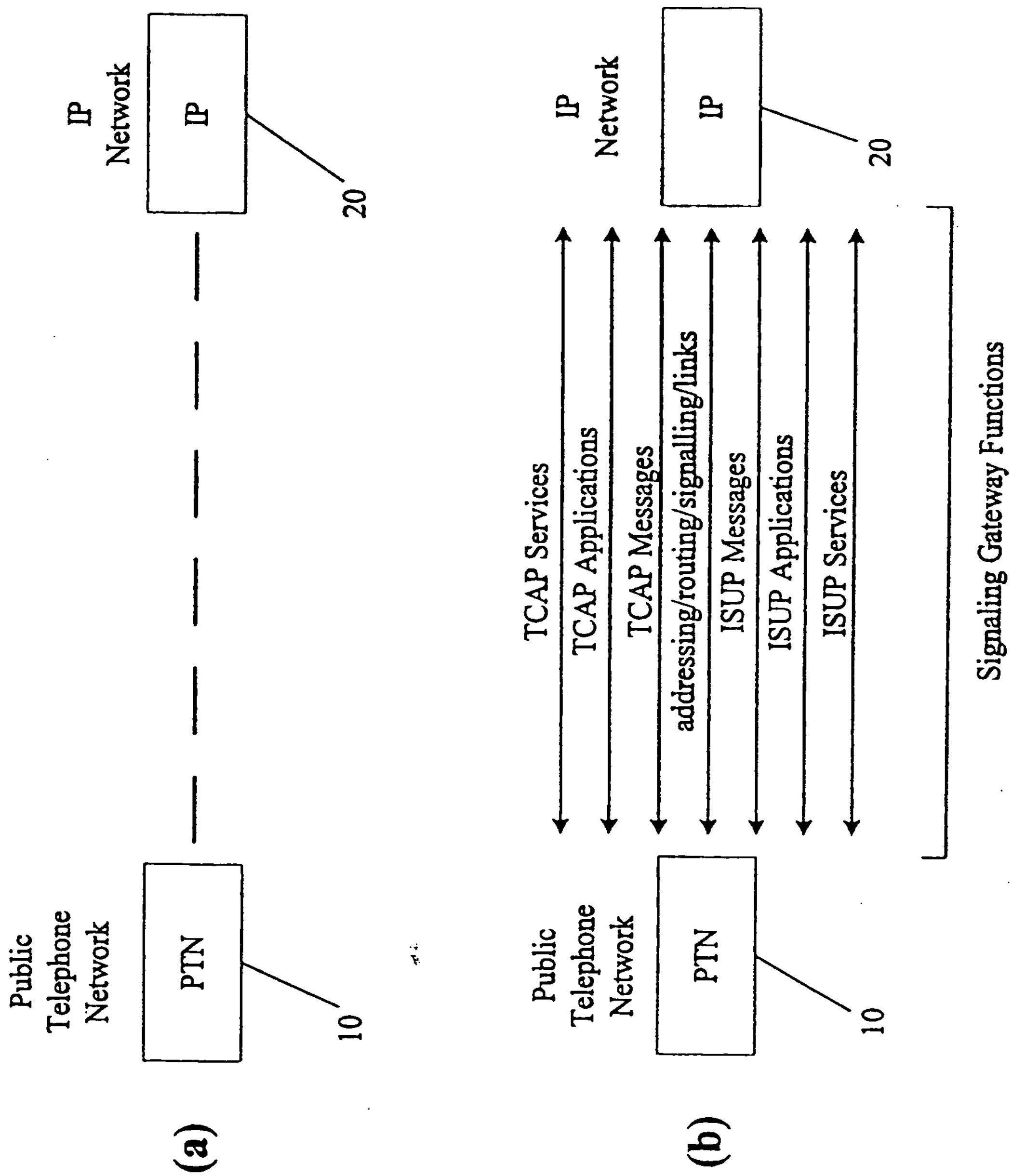
(a)
Public Telephone Network
PTN
10
IP Network
IP
20
(b)
Public Telephone Network
PTN
10
IP Network
IP
20
TCAP Services
TCAP Applications
TCAP Messages
addressing/routing/signalling/links
ISUP Messages
ISUP Applications
ISUP Services
Signaling Gateway Functions

Figure 1

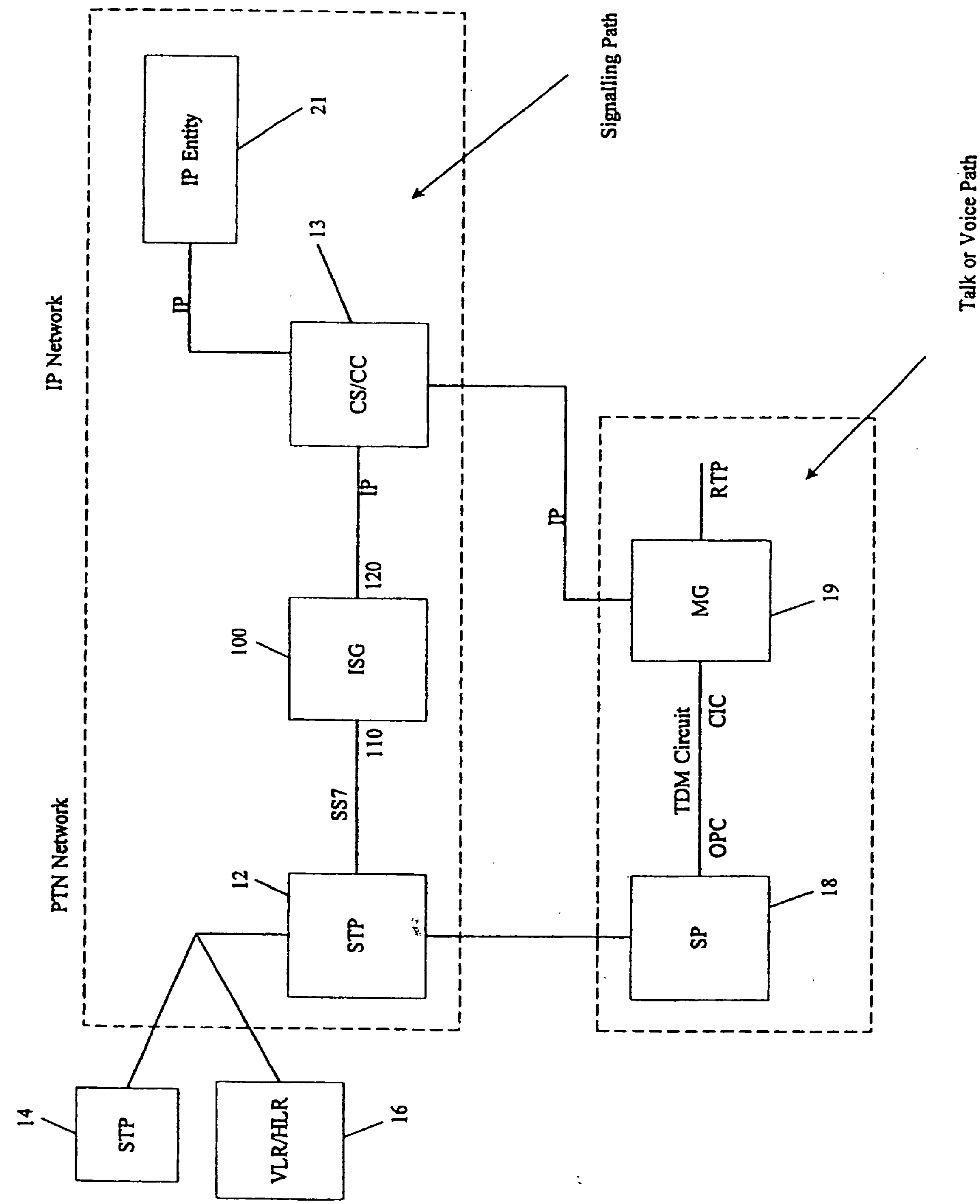
IP Network
PTN Network
IP Entity
21
13
IP
CS/CC
IP
120
ISG
100
110
SS7
STP
12
STP
14
VLR/HLR
16
Signalling Path
Talk or Voice Path
RTP
MG
19
IP
CIC
TDM Circuit
OPC
SP
18

Figure 1(c)

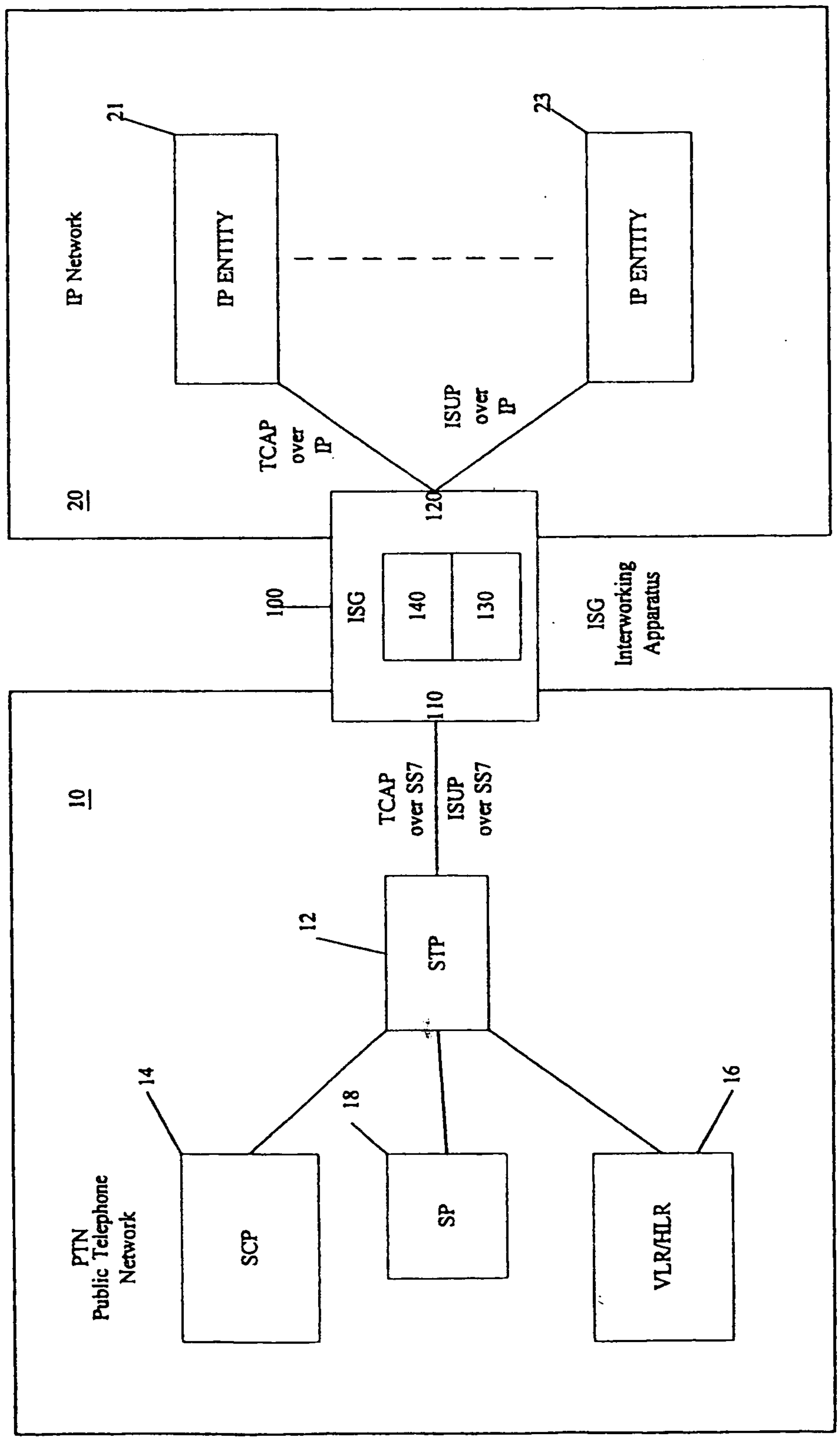
IP Network
20
IP ENTITY
21
IP ENTITY
23
TCAP over IP
ISUP over IP
120
ISG
100
140
130
ISG Interworking Apparatus
110
10
TCAP over SS7
ISUP over SS7
STP
12
PTN Public Telephone Network
SCP
14
SP
18
VLR/HLR
16

Figure 2(a)

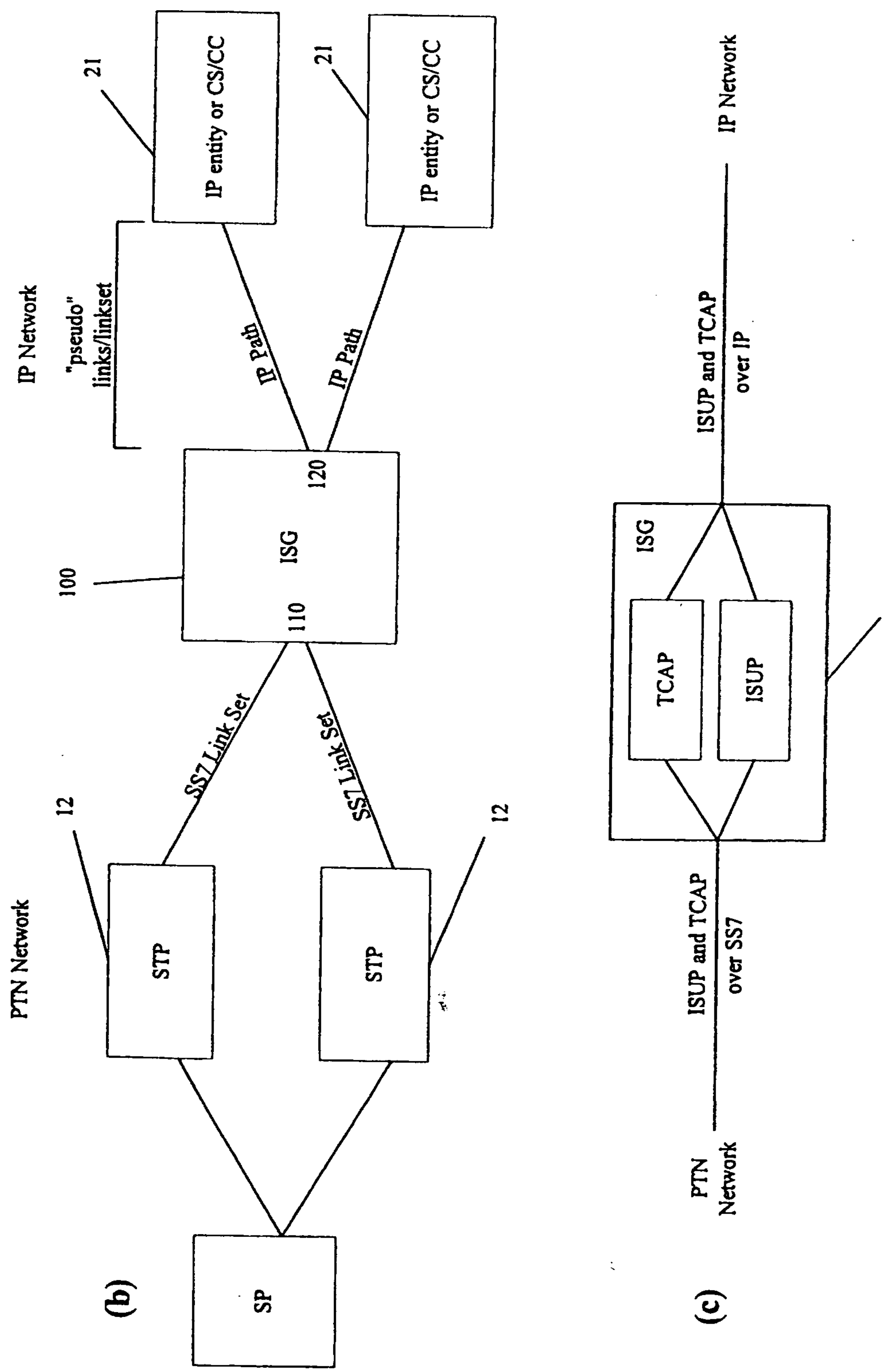
(b)
SP
STP
STP
PTN Network
12
12
SS7 Link Set
SS7 Link Set
110
ISG
120
100
IP Path
IP Path
IP Network
"pseudo"
links/linkset
IP entity or CS/CC
IP entity or CS/CC
21
21
(c)
PTN Network
ISUP and TCAP over SS7
TCAP
ISUP
ISG
100
ISUP and TCAP over IP
IP Network

Figure 2

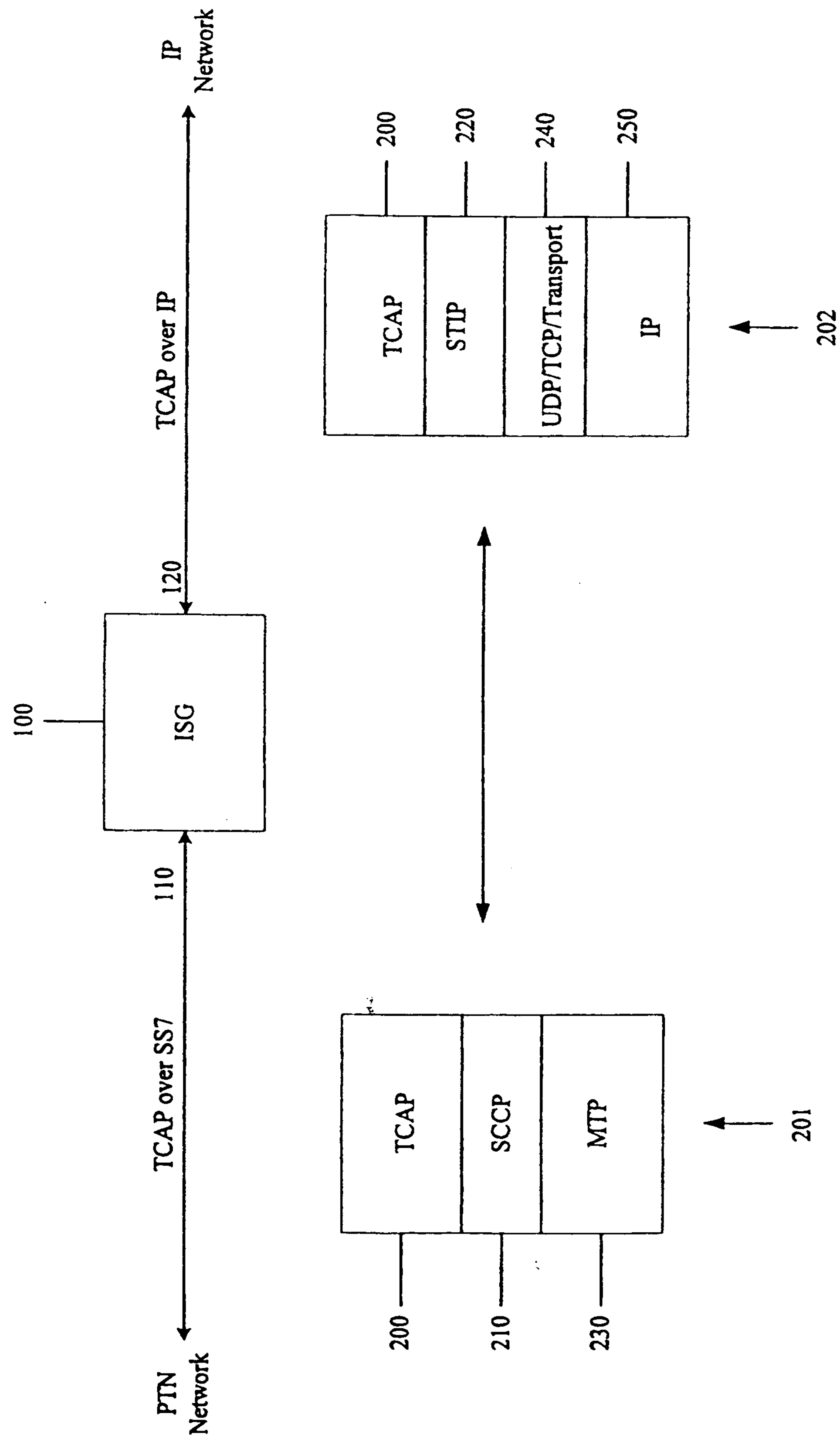
IP Network
TCAP over IP
120
100
ISG
110
TCAP over SS7
PTN Network
200
220
240
250
TCAP
STIP
UDP/TCP/Transport
IP
202
TCAP
SCCP
MTP
201
200
210
230

Figure 3(a)

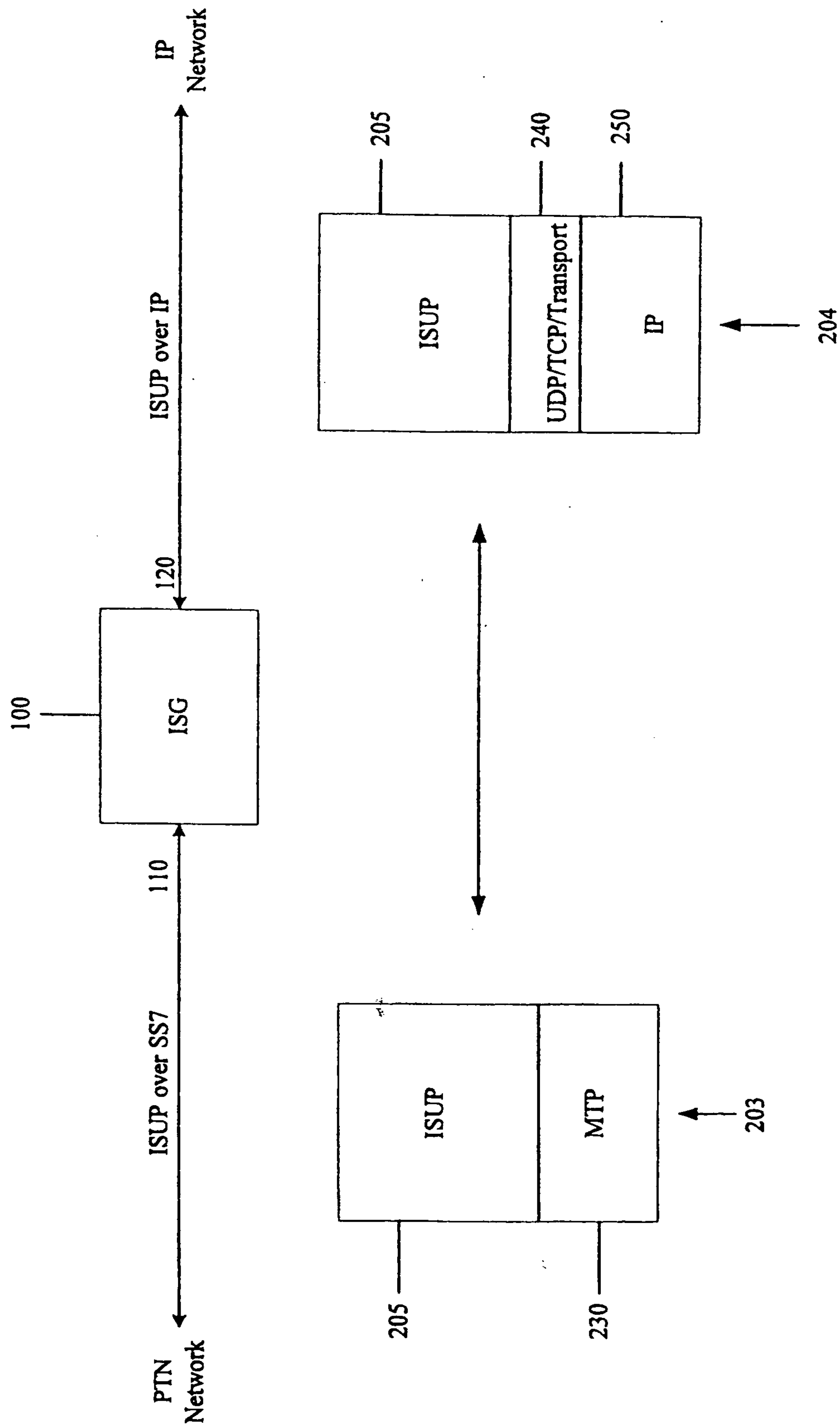
IP Network
ISUP over IP
120
100
ISG
110
ISUP over SS7
PTN Network
205
240
250
ISUP
UDP/TCP/Transport
IP
204
ISUP
MTP
203
205
230

Figure 3(b)

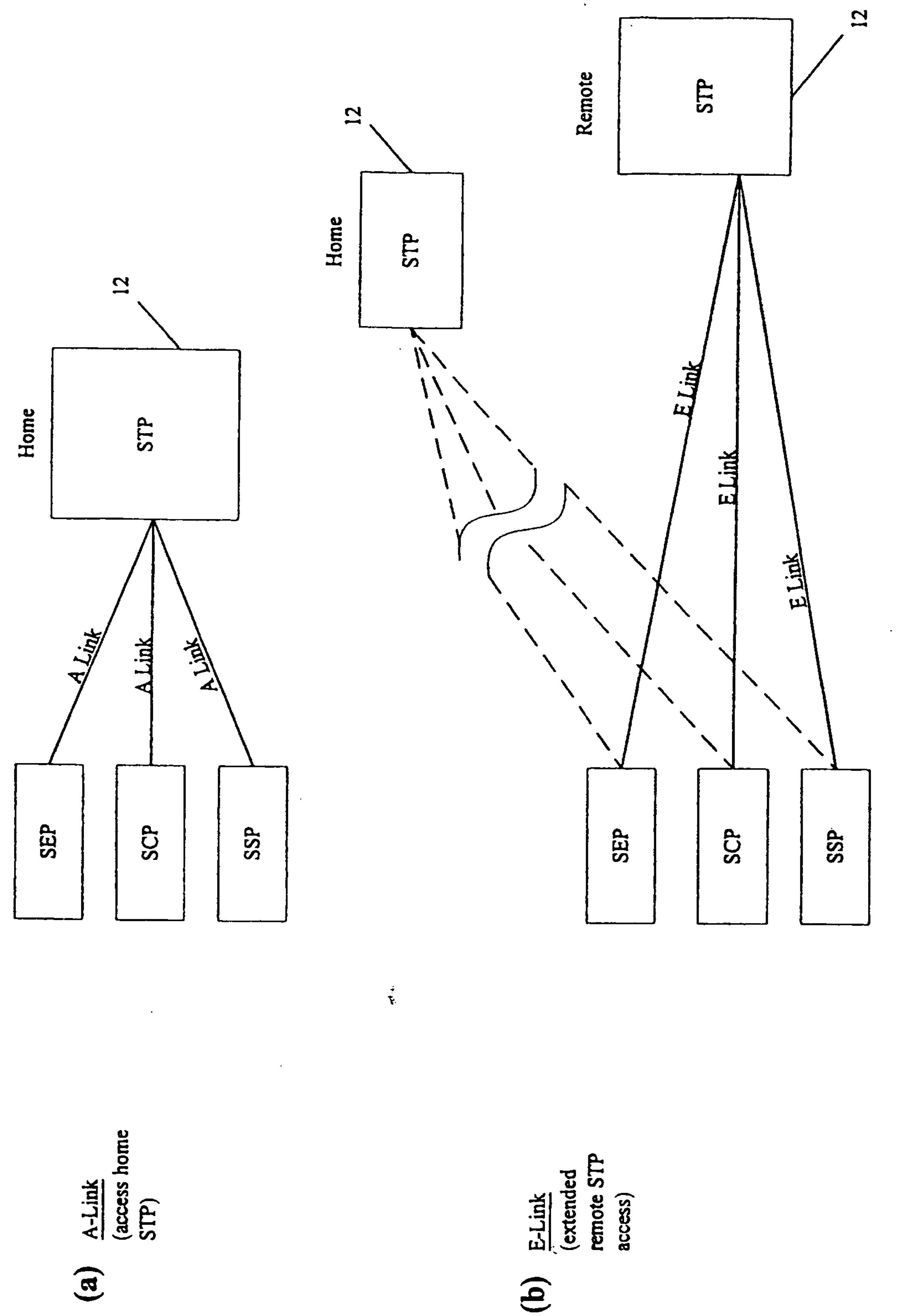
(a) A-Link
(access home STP)
Home
STP
12
A Link
A Link
A Link
SEP
SCP
SSP
(b) E-Link
(extended remote STP access)
Home
STP
12
Remote
STP
12
E Link
E Link
E Link
SEP
SCP
SSP

Figure 4

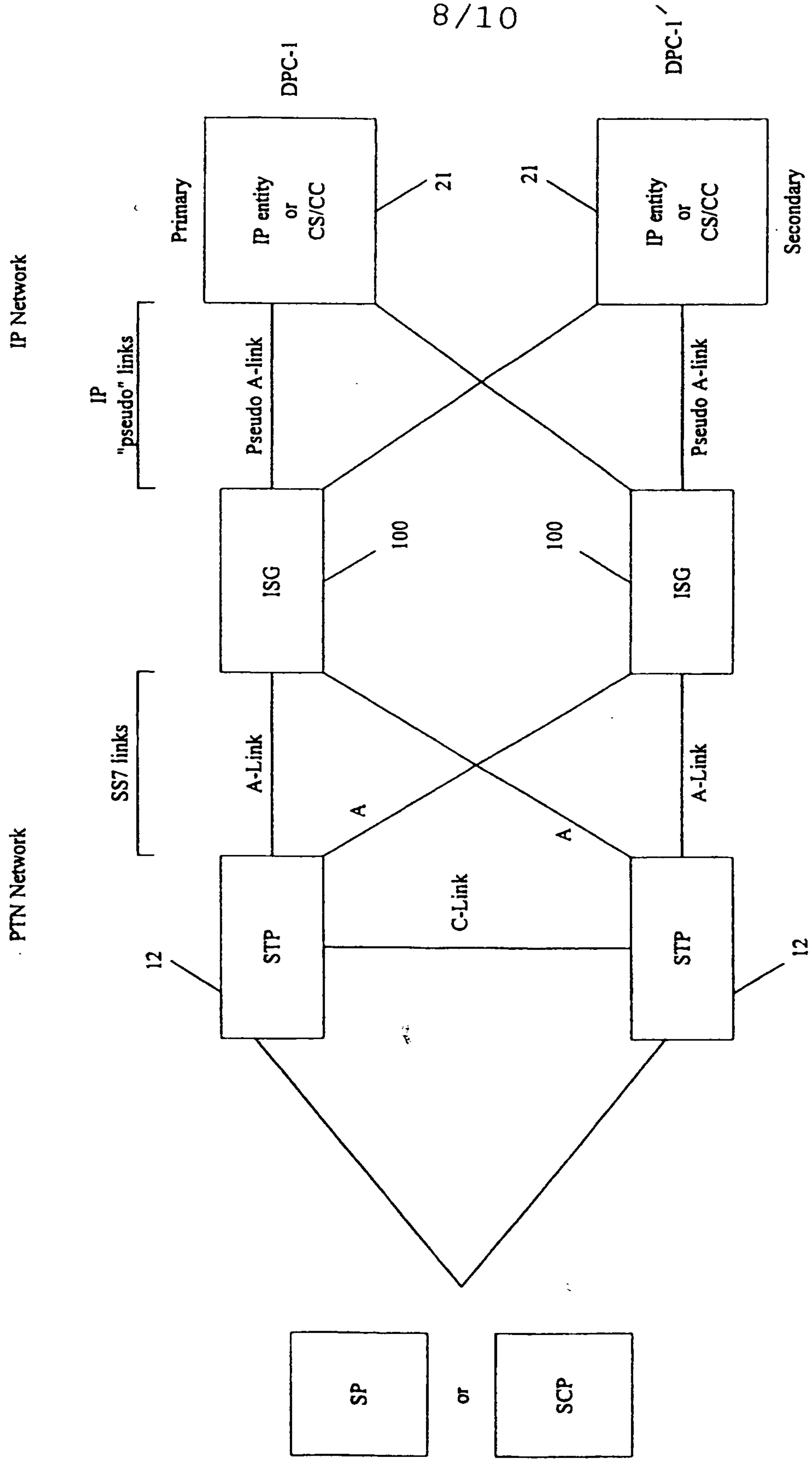
PTN Network
IP Network
SS7 links
IP
"pseudo" links
DPC-1
DPC-1'
Primary
Secondary
IP entity
or
CS/CC
21
Pseudo A-link
A-Link
A
ISG
100
STP
12
C-Link
SP
or
SCP

Figure 5(a)

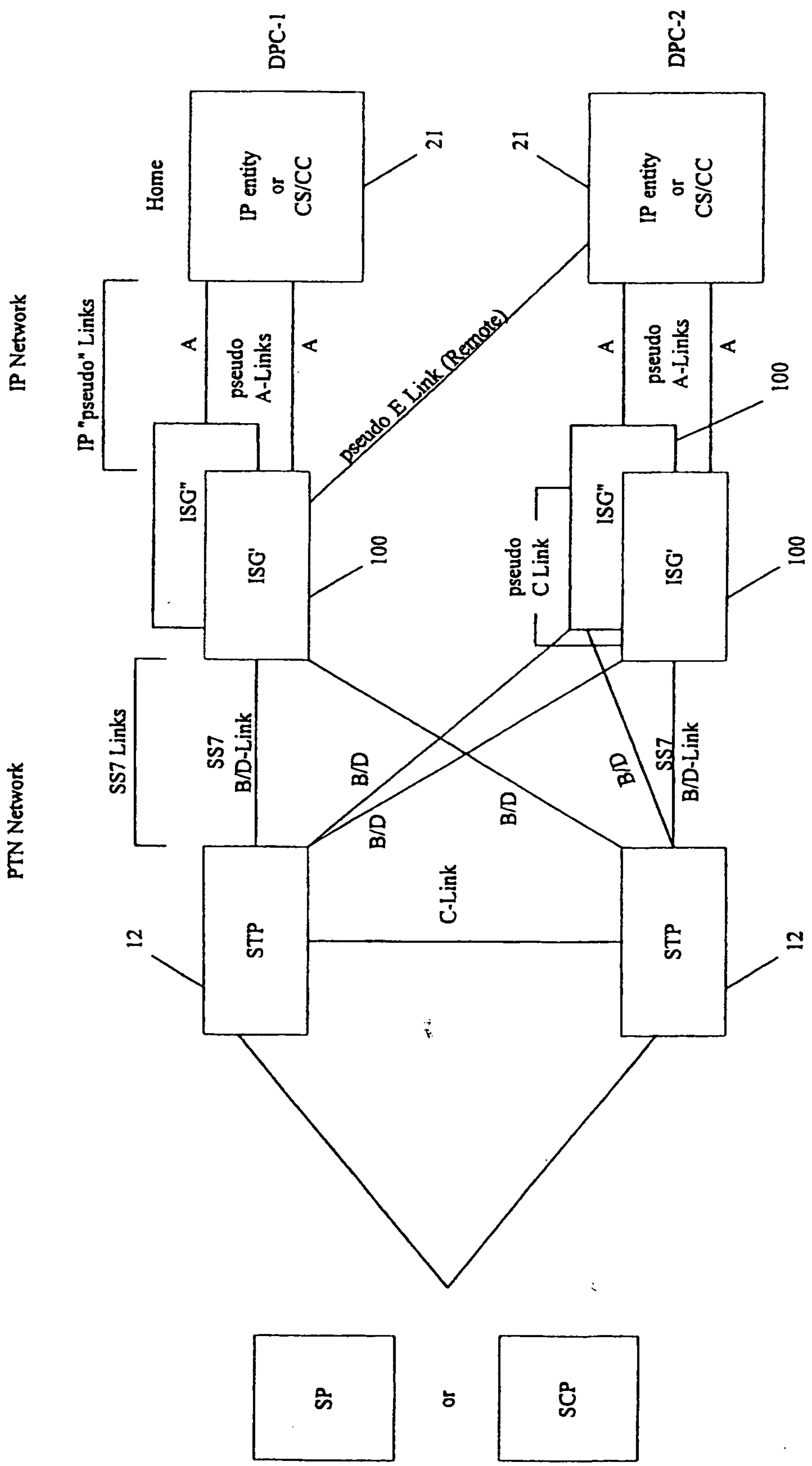
DPC-1
DPC-2
Home
IP entity or CS/CC
IP entity or CS/CC
21
21
IP Network
IP "pseudo" Links
A
pseudo A-Links
A
A
pseudo A-Links
A
pseudo E Link (Remote)
100
ISG"
ISG'
100
pseudo C Link
ISG"
ISG'
100
PTN Network
SS7 Links
SS7 B/D-Link
B/D
B/D
B/D
B/D
SS7 B/D-Link
C-Link
STP
STP
12
12
SP
or
SCP

Figure 5(b)

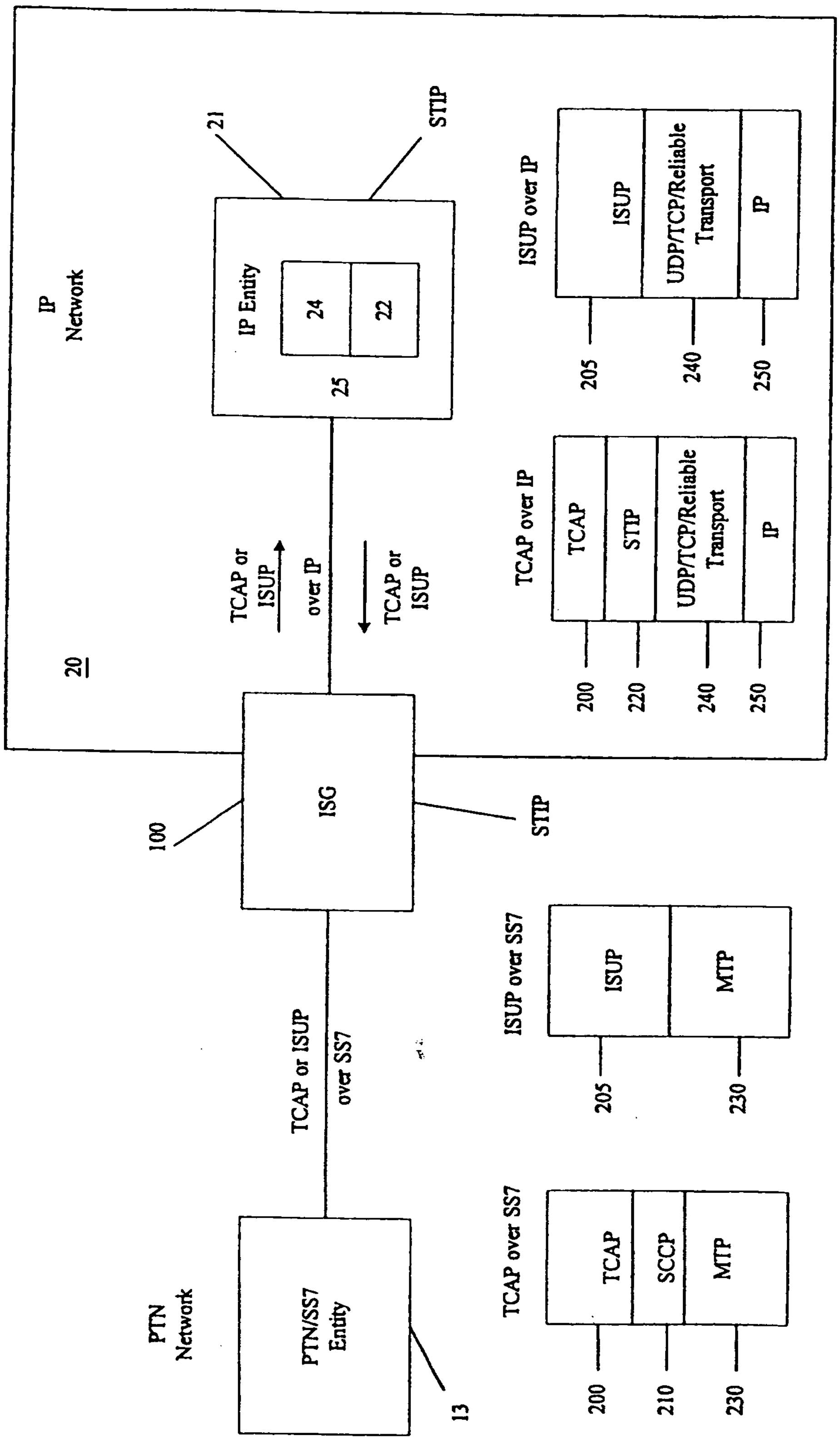
PTN
Network
PTN/SS7
Entity
13
TCAP or ISUP
over SS7
ISG
100
STIP
IP
Network
20
TCAP or
ISUP
over IP
TCAP or
ISUP
IP Entity
24
22
25
21
STIP
TCAP over SS7
TCAP
SCCP
MTP
200
210
230
ISUP over SS7
ISUP
MTP
205
230
TCAP over IP
TCAP
STIP
UDP/TCP/Reliable
Transport
IP
200
220
240
250
ISUP over IP
ISUP
UDP/TCP/Reliable
Transport
IP
205
240
250

Figure 6

INTERNATIONAL SEARCH REPORT

Internati .l Application No
PCT/IB 00/01236

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q3/00 H04L12/66

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HAMDI M ET AL: "VOICE SERVICE INTERWORKING FOR PSTN AND IP NETWORKS" IEEE COMMUNICATIONS MAGAZINE,US,IEEE SERVICE CENTER. PISCATAWAY, N.J, vol. 37, no. 5, May 1999 (1999-05), pages 104-111, XP000830888 ISSN: 0163-6804 page 106, column 2, line 15 -page 108, column 2, line 2 ---	1-3,5-8, 17,18
X	WO 99 29124 A (ERICSSON TELEFON AB L M) 10 June 1999 (1999-06-10) page 2, line 23 -page 3, line 16 page 5, line 3 - line 9 claims 1-23 ---	1-4,6,7, 17,18

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 November 2000	28/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Chassatte, R

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 00/01236

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 841 831 A (AT & T CORP) 13 May 1998 (1998-05-13) column 3, line 29 -column 4, line 30 claims 1-16 ---	1,6,7, 17,18
X	GB 2 321 159 A (MOTOROLA INC) 15 July 1998 (1998-07-15)	1,17
A	page 19, line 30 -page 20, line 30 claims 1-12 ---	2-16, 18-40
X	EP 0 915 626 A (ERICSSON TELEFON AB L M) 12 May 1999 (1999-05-12)	1,17
A	column 2, line 20 -column 6, line 16 claims 1-10 -----	2-16, 18-40

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IB 00/01236

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9929124 A	10-06-1999	AU 1580499 A	16-06-1999
		GB 2347047 A	23-08-2000
EP 0841831 A	13-05-1998	CA 2217838 A	07-05-1998
		JP 10173696 A	26-06-1998
GB 2321159 A	15-07-1998	US 6026086 A	15-02-2000
		AU 5030698 A	16-07-1998
		BR 9800233 A	29-06-1999
		DE 19756404 A	09-07-1998
EP 0915626 A	12-05-1999	AU 1669299 A	31-05-1999
		WO 9925129 A	20-05-1999